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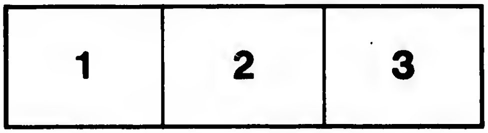

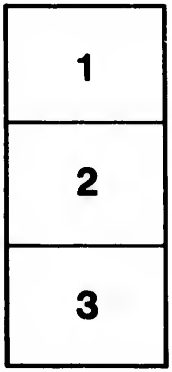

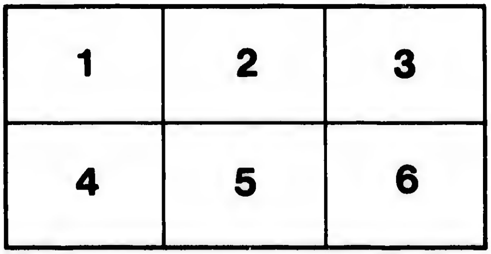

CORPS PAPERS,

AND

MEMOIRS ON MILITARY SUBJECTS;

COMPILED FROM

CONTRIBUTIONS OF THE OFFICERS

OF

THE ROYAL ENGINEERS

AND THE

EAST INDIA COMPANY'S ENGINEERS.

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SECOND NUMBER.

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PREFACE.

In presenting the Second Number of tho Corps Papers to our Brother Officers, both in Her Majesty's and the East India Company's Engineers, we hope the subjects which it contains will be found of an interesting professional character.

Some delay has occurred in the publication of the present Number, owing to impediments in the printing, which it is not necessary to explain.

The attention of young Officers is requested to Lieutenant Gibb's narrative of the military operations at Natal. Its perusal will show them how unexpectedly occasions may occur, even in distant colonies, which call for an exercise of their knowledge as engineers; and how important it is, both to themselves and to tho service generally, that they should be acquainted with all the resources of that art which enables the weak to resist the strong when placed in circumstances similar to those related in the narrative.

We trust that, in an early Number, we shall be enabled to describe some of the engineering details connected with the great military operations now passing in the north-west of India, as also other valuable matter now in hand.

Captain Sir William Denison's paper on Barrack Accommodation and the Moral Conduct of the Soldiers is postponed, as the drawings which are to accompany the paper are not completed.

G. G. Lewis,
Colonel Royal Engineers.

J. Williams,
Captain Royal Engineers.

CONTENTS OF TEXT AND ILLUSTRATIONS.

NARRATIVE of the SURVEY, by the BRITISH COMMISSION, of the BOUNDARY between the BRITISH POSSESSIONS in NORTH AMERICA and the UNITED STATES of AMERICA, under the TREATY of WASHINGTON of the 9th August, 1842*.

1843. THE British Commission was composed of a Commissioner, a secretary, two astronomers, who were selected from the corps of Royal Engineers, two surveyors, one of whom was also from the corps of Royal Engineers, and one a civilian, and six non-commissioned officers of the corps of Royal Sappers and Miners, who had been for a long time employed on the Ordnance Survey of England. These last were found to be so useful, that in the second season, when the operations of the Commission were to be greatly extended, they were increased in numbers to twenty.

Previously to leaving England, the two officers, who were to take the part of astronomers, received from Professor Airy, the Astronomer Royal, instruction at Greenwich in the particular description of observations which he thought suited to the service to be performed. He also superintended the selection of the instruments best fitted to the objects contemplated. They were, for the astronomical purposes, transits, altitude and azimuth instruments, box and pocket chronometers, sextants, and a liberal allowance of thermometers and barometers. For surveying purposes the instruments provided were theodolites, chains, and Schmalchalder's compasses.

The Commission left England in two detachments. The first, consisting of the Commissioner, the secretary, and one surveyor, sailed in the steam-packet from Liverpool on the 4th of April, 1843; and the second on the 19th of the same month. They both landed at Boston; thence, re-embarking on board a coasting steamer, they sailed to St. John's, New Brunswick; and thence, by the river boats, proceeded to Fredericton. In the mean time the Joint Commission was opened, according to the direction of the Treaty, at Bangor in the State of Maine, on the 1st of May, the British and American Commissioners meeting there for that purpose.

At this time the winter was not entirely over: the ground was in general bare of snow, though still there were patches to be seen scattered about in ravines and gullies. In the woods it was even quite deep, in consequence of a recent heavy fall. The 1st of June, therefore, was agreed upon as the time to begin operations; and the interval was to be employed in making preparations. Tents were to be made; provisions collected; camp equipments procured; and axe-men to be hired. On the British side, Fredericton was for the time head-quarters. The tents were procured at Boston; the provision purchased at St. John's; the men hired at Fredericton; and the boats, of which there were to be in the first instance eighteen, were built at Woodstock. One other officer was engaged at Fredericton as a surveyor, who had been employed in previous explorations relative to the disputed Boundary, before the Ashburton Treaty set the matter at rest.

* This Paper has been given by permission of the Right Hon. Secretary for Foreign Affairs.

After leaving Fredericton, the Grand Falls was appointed to be the first place of rendezvous for the British Commission; there everything was to be carried, and a principal depôt to be formed of all such stores as might be wanted for the first season, so far at least as they could be ascertained beforehand.

On the first arrival of the Commission at Fredericton the floods were out on the River St. John; and, indeed, so great had been the rush of ice borne down by the melting snows, that every bridge had been carried away from the Grand Falls to Fredericton, but as soon as these had been temporarily repaired, and the waters had subsided, the Commission removed to the Grand Falls, and from thence began its operations.

These will be described under the different heads of—

1. North Line.
2. St. John.
3. St. Francis.
4. South-West Line.
5. South Line.
6. South-West Branch.
7. Highlands.
8. Hall's Stream.
9. West Line.
10. Astronomical Operations.

These divisions have been adopted for convenience, and a reference to the map accompanying this narrative will, it is supposed, afford a clear idea of the portion of country to which they each relate.

The labourers employed by the British Commission at the beginning of the first season were comparatively few. They did not exceed fifty; but as soon as the cutting of the Line began, they were increased to about 120, and afterwards, in the second season, for the cutting of the Highlands, they amounted to near 500.

Of course preparations on rather an extensive scale were required to provide for the subsistence of so many men at great distances from settlements. Their numbers involved also the necessity of building, in several places, houses for the stores, and for those placed in charge of them. The sort of house was a log-house, in the construction of which lumbermen are very skilful. The principal part of the work is done with the axe alone. The roofings are made of shingles, *i.e.*, pieces of split wood, of the shape and size of slates, laid overlapping each other. Two panes of glass are introduced into the wall to give light; and a small sheet-iron stove makes the house complete. The bed is always made of twigs of the spruce tree placed at an inclination upwards, and lying one upon the other after the fashion of the feathers of a bird; nothing can be more comfortable or more fragrant.

The boats which were used by the Commission were of three sorts: those called "bateaux," which are flat-bottomed and sharp at both ends; those called "pirogues," or log canoes, which are made by hollowing out a spruce-tree, and shaping it; and birch-bark canoes, which are made and used almost exclusively by the Indians. These last are too delicate for carrying heavy burdens. The pirogues are commonly used by the settlers, but they require careful management; whilst the bateaux, which are more properly the boats of the Penobscot, will bear a heavy load, and are not easily upset. They were in consequence preferred for general purposes by the Commission.

For carrying burdens on men's backs, a sort of frame was invented, which enabled them to carry barrels and inconvenient loads as easily as those which fitted better on the back.

The axe-men were, in the first place, settlers from New Brunswick; but afterwards, as the work approached the Canadian frontier, they were engaged from amongst the Canadians, and chiefly from the neighbourhood of Three Rivers. Both descriptions were excellent men, whose energy and endurance were equal to any occasion, and who submitted willingly to the strict discipline which was maintained in the camps of both Commissions.

Though the drain on the constitutions of the men, both from the cold of winter and the great heat of summer, was severe, yet they were for the most part free from sickness. Fevers were only known amongst those who, having been some time in the woods, where there is but little wind, went out into clearings. In the spring, and only in the spring, scurvy was common amongst those who had passed the winter in the woods. The gums became sore, the teeth loose, the legs discoloured, and the whole frame emaciated; but raw potatoes or cream of tartar alleviated the sufferings at once, and a change of diet to fresh vegetables and fresh meat out of the woods soon restored the patient to his usual health. Of injuries there were very few, considering the number of axes which were in motion every day. Axe-men are exceedingly careful to clear away every little twig around the tree they are about to fell, knowing how small a matter will turn a falling axe. There were but three formidable wounds from the axe, and one injury from the falling of a tree. The falling of the tree dislocated the hip of a poor man employed close to it, and crippled him for life. The wounds did not in either case occasion death, but they were formidable from their depth and size, and from the impossibility of having recourse to a surgeon. All the officers were provided with a few simple medicines, needles, thread, plaster, and a tourniquet, which they used as well as they could.

The narrative will now describe the nature of the survey throughout its different portions under the heads already enumerated.

NORTH LINE

North Line. The Treaty fixed upon the Exploring Line of Colonel Bouchette and Mr. Johnson, from the head of the St. Croix northwards to the River St. John, as the Boundary between the British and American possessions. That line had therefore to be sought out; and in consequence, a party from the British Commission was directed to go in company with a party from the United States' Commission, and, if possible, to trace it.

From the monument at the source of the St. Croix, which there was no difficulty in finding, and which agreed with the description given of it by Colonel Bouchette, the parties at first followed a well marked line, which it was easy to see had been cut out to some certain width. It was to be recognised by the trees along it being evidently of a younger growth than the rest; and also by a sort of dip, which was to be observed when looking up, and following with the eye the line of the tops of the trees against the sky.

That line carried the parties to a meadow about half a mile north of the south branch of the Meduxnikeag River, when it suddenly stopped. Neither Commission had, at the time, any information to account for this, and some perplexity was the consequence.

After searching about for some time, the parties discovered, to the east of the line which they had been following, a line of blazes, which ran north, and appeared to resemble the character of the blazes by which the northern portion of the North Line was understood to be marked; for it was known that the upper or northern portion of the North Line had been blazed two or three times over, and that it was marked in that way, but that it was not cut out.

The parties, therefore, followed the above-mentioned blazes northwards, until they came, after seventeen days from the time they began the exploration, to the River St. John.

On the way they fell in with marks on the trees and posts, which confirmed the identity of the Line with that of which they were in search.

After reaching the St. John's, they returned and followed back the same blazes southwards from the point at which they had at first fallen in with them; and in due time they found themselves carried back to the monument at the source of the St. Croix.

The whole line thus explored passed through forest, some of it, especially towards the source of the St. Croix, exceedingly entangled.

There were however a few clearings for cultivation, at Green's; about the Houlton Road; at Watt's, on the south branch of the Meduxnikeag; on the left of the Presqu'isle River; on the banks of the Aroostook; and again on those of the St. John.

North Line.

With regard to the line, which had been supposed at first to be the true one, and which had been followed to the meadow, as already stated, its history was ascertained from Mr. Campbell, who had been one of the assistant surveyors under Colonel Bouchette, and who was still living at St. Andrew's in New Brunswick. Upon application being made to him, he sent his field-notes for examination, from which it appeared that Colonel Bouchette and Mr. Johnson had, in 1819, gone a-head with an exploring line, directed by compass, leaving their assistants to trace, and cut out to the width of sixteen feet, a more exact due north line: but those gentlemen, after running their line to the meadow above mentioned, found themselves so far from the exploring line of their principals, that they doubted their own accuracy; and not being able to agree on the matter, they stopped altogether, and left the woods.

After the North Line had been traced and re-blazed by the Boundary Commission in 1843, parties were employed to cut it out to the width of thirty feet; it having been agreed that all portions of the Boundary which should pass through woodland should be opened to that width.

The American Commissioner undertook to cut with his parties that portion of the Line which was south of the Presqu'isle River, whilst the British Commissioner with his parties cut all that was north of it.

After the Line had been cut out it was surveyed by a party from each Commission.

The mode of determining where the precise Line should be, was, by running a succession of courses, and making each any length most convenient, provided it did not stretch out beyond the cutting of thirty feet width.

The general bend of the line was to the west: until near the St. John its deviation from the meridian of the St. Croix, measured on the perpendicular, amounted to 2,197·8 feet. This measurement was obtained on the perpendicular drawn from the Transit Station of the British Commission at the Grand Falls.

At each mile, and at each angle of deflection, as well as at the crossings of the roads, where any occurred, or at those of the rivers, an iron post was set up. The posts were cast at Boston, of an uniform pattern. There were two sizes: a large size, which was placed at the principal points, such as the source of the St. Croix, and the intersection of the St. John, on the North Line; and at other points upon other portions of the Boundary, of which mention will be made by-and-by: and there was a smaller size, which was placed at intervals all along the line.

RIVER ST. JOHN.

er St. John.

The River St. John was surveyed by two parties from each Commission. One British and one American party surveyed in company upwards from the Grand Falls to the mouth of the Madawaska; and another British with another American party surveyed downwards from the mouth of the St. Francis to the mouth of the Madawaska, where the two surveys were brought together.

In the neighbourhood of the islands, soundings were taken to ascertain the deep channel; and by them the Commissioners determined on which side the Boundary should be made to pass.

The only island about which there arose a doubt was La Septième Isle; and in that case the Commissioners determined to apportion it to the side on which the greater number of the owners should be found to live. By that decision it fell to the United States.

The banks of the river are settled nearly all along from the Grand Falls to the Madawaska River. Above that point the settlements are less frequent.

RIVER ST. FRANCIS.

ver St. Francis.

The River St. Francis was surveyed by a party from each Commission acting together.

The outlet of Lake Pohenagamook was determined and marked.

The whole course of the St. Francis was through uncleared woodland. The scenery on it was very beautiful: the trees rich with foliage; the width of the river sometimes diminishing to a narrow channel, and then again opening out broader, and even spreading itself into large and long lakes.

Lake Pohenagamook is the third principal lake, and is about six miles long.

Before relating the astronomical operations, it will be necessary to mention what arrangements were made for supplying with provisions the parties to be employed in the Valley of the St. John beyond the St. Francis.

Up to the St. Francis, the St. John, though shallow in parts, was yet generally capable of floating a flat-bottomed boat, called a "scow;" but above the mouth of the St. Francis it was found to be for the most part, except when swollen by an unusual quantity of water, too shallow for transporting any large quantity of provisions. It was, therefore, necessary to seek some other route. That which was determined on was to cut a road through the woods from St. Thomas, a town on the St. Lawrence, about thirty miles below Quebec, to the north-west branch of the St. John; a distance, as it turned out, not less than forty-one miles. Bridges and causeways, wherever necessary, were constructed upon it. It was begun from the side of St. Thomas; and thus, as the provisions were wanted for the workmen, they were carried in after them on carts by the road they were cutting.

A triangulation was being made at the same time of the country intervening between the north-west branch and the crest of the dividing ridge towards the St. Lawrence, in which direction it so happened, fortunately, that there were several prominent hills which facilitated the operation.

ASTRONOMICAL OPERATIONS.

tronomical
rations.

A chain of astronomical stations was established between the Grand Falls and the outlet of Lake Pohenagamook. Comparative longitudes were obtained between those stations by interchanges of chronometers; thus, the Grand Falls and the mouth of the Madawaska River were the first stations taken up. As soon as the officers had determined the time at their stations, chronometers were transmitted from one to the other.

After that had been satisfactorily accomplished, the Grand Falls were abandoned, and the mouth of the St. Francis was taken up; and then the connection was made between that and the Madawaska. Then the Madawaska was given up, and the outlet of Lake Pohenagamook was occupied.

In this manner the Grand Falls were connected astronomically with the outlet of Lake Pohenagamook, which being accomplished, the second object was to connect the outlet with a certain point on the north-west branch of the St. John, which was determined according to certain conditions of the Treaty: for it was directed that the boundary between those points should be a straight line; and the whole intervening country, a distance of more than sixty miles, being one unbroken forest, it was necessary to connect those two points astronomically in latitude and longitude, and so to compute their azimuths.

To effect this, a chain of stations was taken up by the only practicable, though circuitous route of the St. Francis and the St. John, in the same manner as had been already done between the Grand Falls and Lake Pohenagamook.

They were—

1. Outlet of Lake Pohenagamook.
2. Mouth of the St. Francis.
3. Mouth of the Great Black River.
4. The Forks of the St. John, or end of the Ten-Mile Line.

This Ten-Mile Line had been cut by the American Commission from the St. John to the point fixed on the North-West Branch. It was a measured distance of ten miles; and, besides being the means of fixing the point on the North-West Branch, it served to complete the connection between the outlet and the North-West Branch.

Astronomical observations.

But before these operations were finished winter had set in; the communication between the stations had ceased. The last party which attempted to pass between the mouth of the Great Black River and the Forks had been obliged to abandon their canoe, and scramble the rest of their journey along the sides and banks of the river. It had been determined, however, beforehand, to endeavour to persevere, notwithstanding the winter; and accordingly preparations had been made: houses had been constructed, in which it was hoped the parties would be able to remain during at least so much of the winter as might be found necessary; and stores and provisions had been laid in.

After the river had become impassable for canoes, the parties waited for it to freeze, hoping that it would prove possible to effect a communication by sleighs.

The interval which elapsed between the closing of the navigation by canoe, and the opening of it by sleigh, was ten weeks; *i. e.*, from the beginning of November to the 10th of January.

The arrangement for carrying the chronometers by sleighs required a stable for a change of horses intermediate between the astronomical stations; and the service was attended with a great deal of exposure; so much so, that it required great persuasion and management at times to induce the Canadians, who had undertaken the employment, to continue in the service. Their horses suffered for want of good stabling, and from the fatigue attending their journeys: continually they were obliged to break a fresh track through the recently fallen snow; and frequently to stop to strike off the heavy burden of ice, which would collect and attach itself about the fetlocks of the animal. The service was however successfully accomplished; and thus a complete connection was made between the extremities of the long South-West Line; and the data were obtained for computing the direction of one from the other.

The parties then left the woods by the way of St. Thomas.

The winter was employed also in carrying in to the depôt on Lake Ishæganalshegeck, on the North-West Branch, a very large supply of provisions; enough, in fact, to last for all the remainder of the operations likely to be required in the valley of the St. John. They were carried in on sleighs, and an officer was placed in charge of them.

Using that as the principal depôt, other subsidiary depôts were formed: one at the opposite side of the Lake Ishæganalshegeck; another at the Forks, or end of the Ten-Mile Line; another at the mouth of the Great Black River; and another near the outlet of Lake Pohenagamook: but this last was supplied from Rivière du Loup by a road cut by the lumbermen from Fournier's on the Temiscouata Portage Road.

In this way provisions were stored in sufficient quantities, and in convenient depôts, for the operations calculated on for the valley of the St. John.

The foregoing operations may be considered as those of the first season, though they did in fact extend through the whole of the winter.

They are shortly comprehended in the following:—

A survey of the North Line.
A survey of the St. John River, with its islands.
A survey of the St. Francis River.
Astronomical data for computing the azimuth of the South-West Line.
And a large supply of provisions collected at certain depôts.

1844. The month of February being permitted to pass in inactivity, the Commission was again ready in March to begin operations; and it was determined to take advantage of the hollowness of the woods and the absence of foliage, and of the snow, which covered up the obstructions on the ground, and made it easier to pass between the trees with snow shoes. Accordingly, by the 1st of March, the two sets of labourers were on the ground, one at Lake Pohenagamook, and the other at the North-West Branch; and preparations were made for running a trial line from both ends at once.

South-West Line.

The following was the mode of proceeding at the North-West Branch:—

The azimuth of the line to be run, which had been computed from the astronomical data, as already mentioned, was first laid off with a large altitude and azimuth instrument, and then the line was prolonged with a transit.

It so happened that, after running about four miles, the Line passed over the shoulders of a hill, which rose like a sugar-loaf; and, after removing the transit to that point, it was found to command a view over the tops of the successive ridges for nearly forty miles. This was great luck, which the party at Lake Pohenagamook did not share. They, on the contrary, had their view obstructed by hill after hill, entailing frequent removals of the transit.

The party which actually ran and cut the Line worked their way by compass; but at night they were enabled to obtain a correction for themselves from the Transit Station, in the following manner:—A torch of birch bark was visible with great ease even to the distance of forty miles; also flashes of gunpowder fired in an open pan could be seen to at least the same distance. Signals were agreed upon, as thus:—One flash, "Move more to the right;" two flashes, "Move more to the left;" three flashes, "Halt;" and four flashes, "All right." As soon as it became dark the torch was set up by the working party; the officer at the transit, observing the deviation of the torch from the true position, made signals, in obedience to which the torch was moved, until it was seen to be bisected by the centre wire of the transit. When that was the case, the signal of four flashes was made, and a post firmly driven into the ground was substituted for the torch. In due time the parties from the opposite ends were expected to be approaching each other, though no communication had been as yet opened between them; and great was the anxiety to learn how near they were drawing to each other, and what amonnt of error there would be between the two lines. The first indication of the cutting party from Lake Pohenagamook was an apparent dip or opening on the outline of the tops of the trees, seen by a man who had climbed a tree to look out. The suspicion that it might be the other party, became a certainty that it was so, by the opening being observed to grow larger; at length they came alongside of each other, when their deviation from the correct course was found to be only 341 feet, *i.e.*, an error for each of 170½ feet, supposing each to have run the same distance.

The degree of accuracy which this result implied will be perhaps better understood by quoting the statement of Professor Airy. When writing on the subject, and expressing his satisfaction at the manner in which the officers charged with the astronomical operations had performed their parts, he said that the error was so small, that it was less than the loss of one beat of a half second chronometer; that is, that during the circuit of astronomical stations and the interchange of chronometers, which had taken place in order to obtain the comparative longitude between the extremities of the South-West Line, of which a description has been given, there had not occurred the loss of one whole beat of a chronometer constructed to beat half seconds.

The error being ascertained, it was necessary to correct it; and this was done by running offsets at certain points along each line of lengths proportional with their distances from the extremities. The corrected line was then run through the points fixed by the offsets; and afterwards parties were put on to open it to thirty feet.

During the progress of the operations just described, the snow, which had been from four to five feet deep, had gradually melted, entailing thereby great difficulties. By degrees the snow shoes became useless, and yet without them the men sank the full depth of their legs into moist, half-melted snow, excessively difficult to get through. Add to this, the streams became rivers, and the rivers deep torrents. As an example of the labour of pushing through the snow in its moistened state, whilst it was still deep, one party was four days going ten miles.

South Line.

The next operations in the valley of the St. John were to determine the parallel of latitude 46° 25′ on the South-West Branch, and then to run the South Line.

Astronomical observations.

The further astronomical operations of 1844 were to connect the North-West Branch with Quebec.

A high hill rose above Lake Ishægana!shegeck, which was made an astronomical station, and was connected by triangulation with the boundary point on the North-West Branch. Then a hill was sought out upon the highest ridge intervening between the valley of the St. Lawrence and the valley of the St. John in the direction of Quebec. Having found a spot, the tops of the trees on which could be seen both from the station on the hill above Lake Ishæganalshegeck and from the observatory which was established on the Plains of Abraham, near the citadel of Quebec, flashes of gunpowder were fired from it. These being seen, and the times noted at each of the two astronomical stations, the difference of longitude was obtained.

HIGHLANDS.

Highlands.

Turning now to other operations of the season, the attention is directed to the Highlands stretching from the source of the south-west branch of the St. John to the source of Hall's Stream, along which portion the Boundary was directed to follow the dividing ridge of the waters. The whole of that district, embracing about 180 miles in length, was forest; there was but one road through it, and that led almost due south from Quebec towards Boston in the United States.

The method adopted for finding the dividing ridge of the waters, as well as for obtaining the means of mapping it down afterwards, was this :—

Setting out from the height of land on the Kennebec Road, guide-lines, as they were called, were cut through the wood, one eastward and another westward, and, as nearly as could be guessed, in the general direction of the dividing ridge. From these guide-lines offsets at distances of about half a mile were run over the dividing ridge; leaving water flowing, say, into the St. Lawrence, they were made to cross over the hills, and were prolonged until they struck water flowing in the opposite direction, through the Valley of the Kennebec. The highest point between those waters flowing in opposite directions would be, as a general rule, on the dividing ridge; and thus a succession of summits was obtained, which, when connected, formed the Boundary required by the Treaty. In order to connect those summits, the practice pursued was to send a man to blow a horn at one summit, which, being heard at the next, afforded a guide to a party, which, following the highest ground about them through all its different windings, listened to the blowing of the horn, and inclined that way whenever the ground admitted of their doing so; and thus they blazed a line from one summit to the other. The direction of the guide-lines was altered whenever it was deemed necessary; but both the guide-lines and the offsets being chained, and their angles of direction observed, they afforded base lines by which to correct the traverse along the actual Boundary. Another correction was also resorted to, viz., bearings of high conspicuous points, which discovered themselves as the work went on.

The line along the dividing ridge having been blazed, it was cut out to the established width of thirty feet; to accomplish which in the shortest time large parties were employed. The guide-lines and offsets very much facilitated the operation, by enabling different working parties to get in upon the Boundary at several points at once, without interruption to each other.

The principal difficulty was the keeping up a supply of provisions to the working parties. The labour of carrying them on men's backs into the woods to such great distances as forty miles, which was the case when the cutting of the Boundary had made some progress, was very great, so great that a constant supply of fresh men was required for the purpose; for it always happened that many of the men who had made one trip into the woods with a load on their backs, refused, upon their return, to undertake another.

The heat, the rain, the difficulties of the paths—sometimes very steep, and sometimes very marshy,—the snow afterwards, as the season advanced, and the insufficient shelter, combined to discourage them, and to make it necessary to arrange for a constant succession of fresh men to be sent up from distant settlements.

To complete the cutting of the Boundary up to the source of Hall's Stream was a race against the season ; and the snow was already two feet deep before it was accomplished. It was finished, however, before the parties left the woods; and thus the amount of Boundary cut during the season was from the outlet of Lake Pohenagamook to the source of Hall's Stream, a distance of about 264 miles, of which the British Commission had cut 224 miles. This was a larger portion of the work than properly would have fallen to the share of the British Commission, had it not been agreed between the Commissioners, for the sake of expedition, that the principal part of the cutting during this season should be done by the British Commission, whilst all that should remain to be cut of the Boundary from the source of Hall's Stream, to the end, should be accomplished by the American Commission afterwards.

During the winter of 1844 45 the iron monuments were carried to their places all along that portion of the Boundary which had been cut during the season as above mentioned.

Along the South-West and South Lines, as well as up the south-west branch of the St. John to its source, they were hauled on sleighs drawn by horses; but along the Highlands that was impossible, and therefore a party of eighty Canadians, under a confidential and very determined foreman, was employed for the purpose, prepared with hand-sleighs, called by the Indians "tabaugens," but of a strong description.

They entered the woods in January, near Hall's Stream; deposited the monuments at certain points along the Boundary; and came out at the height of land on the Kennebec Road. The service was one of severe labour and exposure. Sometimes all hands were required to haul each monument in succession up a precipice; sometimes a violent snow-storm would cross the hills where the men were at work, and they would scarce be able to keep body and soul together.

1844-5.

The season of winter was also employed to survey on the ice the South-West Branch of the St. John, the South Branch, the North-West Branch, the Matawaquam, the main St. John down as far as the St. Francis, the Great and Little Black Rivers, and the Ktjemquospem.

When the working season of 1845 began, the monuments, which had been laid down at the places destined for them, were erected along the south-west and south lines, also along the Highlands. The traverse of those portions of the Boundary was likewise completed. Hall's Stream was surveyed; and the 45th parallel was explored, cut out, and surveyed.

Astronomical observations.

The astronomical observations were also continued between Quebec and the 45th parallel; and as Quebec had been previously connected with the north-west branch of the St. John, it followed that a complete chain of astronomical observations had been determined, extending from the Grand Falls of the St. John through the Valley of the St. John, and over to the 45th parallel, by Quebec and Montreal.

Hall's Stream.

Hall's Stream was surveyed by running a guide-line from its intersection by the West Line, that is, by the Line of Valentine and Collins, in a northerly direction, then by running offsets from that guide-line to the river, and by a traverse along the stream itself.

WEST LINE.

West Line.

The Line of Valentine and Collins was found near Canaan Corner. The people of the country pointed it out. They showed a line of old blazes, as also a place where a post had stood near the Connecticut, about a mile further to the eastward than Hall's Stream. The old blazes were examined at different places along the line between Hall's Stream and St. Regis, and were found to date back to 1772, 3, and 4. These old blazes were traceable the whole extent of the line, except where clearings intervened. Other old marks were likewise found, of which the most remarkable were an old post on Province Point, in Mississquoi Bay, and the foundation, in masonry, of the monument which had stood near Rouse's Point, on the left bank of the Richelieu. It had been covered over with mould by time, and no appearance of it remained on the surface of the ground, which was marshy and covered with long coarse grass; but a man of the neighbourhood remembered it, and pointed out where it stood; and there, upon digging, the square mass of masonry was discovered, the foundation of the original monument.

The line along the 45th, the West Line, as it is designated in the Report and in the Maps, was found to be exceedingly crooked; therefore in marking it the same method was adopted for correcting its deviations as had been resorted to on the North Line, by a succession of straight lines kept within the cutting of thirty feet.

Wherever clearings occurred, the line was made to run straight across them, from authentic marks on the one side to authentic marks on the other side of the same clearing.

ronomical rations.

The astronomical operations for the season were, in detail, as follows:—

Montreal was connected with Quebec, and St. Regis and Rouse's Point with Montreal, by interchanges of chronometers, for which the steamers on the rivers afforded great facility; then St. Regis was connected with Rouse's Point by signals of flashes, as the North-West Branch had been with Quebec. A high hill, called Lion Hill, served as the signal station.

Richford and Lake Memphramagog were likewise connected with Rouse's Point by signals from Jay Mountain, in Vermont.

Afterwards the intersection of Hall's Stream by the West Line was connected with Lake Memphramagog by interchanges of chronometers. Added to these, Rouse's Point was connected with the observatory at Cambridge, near Boston, also by interchanges of chronometers.

It has been stated in the early part of this narrative, that monuments of a smaller size were erected along the Boundary, and others of a larger size at only certain points. The following is a list of the places where the larger monuments were erected, viz.:—

- The source of the River St. Croix.
- The intersection of the River St. John by the North Line.
- The outlet of Lake Pohenagamook.
- The Boundary Point on the North-West Branch.
- On the left bank of the South-West Branch, at its first intersection by the South Line.
- On the left bank of the South-West Branch, at its intersection by the parallel of latitude 46° 25′.
- At the first point on the Highlands near the source of the South-West Branch.
- On the east side of the Kennebec Road.
- At the source of Hall's Stream.
- The intersection of Hall's Stream by the West Line, on the right bank.
- The intersection of the River Richelieu by the West Line, one monument on the right bank and another on the left.
- The intersection of the St. Lawrence by the West Line, near St. Regis.

The foregoing narrative explains the process by which the Line of Boundary was explored, and traced, and marked, and surveyed, throughout its whole length.

It is possible that it might be useful to know precisely what portions of the work were done by American Commissioners and what by the British.

The following, then, is an account of those proportions:—

NORTH LINE.

The exploration was made by a party from each Commission. The cutting was divided: that portion of the line which was south of Presqu'isle River was cut by the

Americans, and that portion which was north of that river was cut by the British. The survey was executed by a party from each Commission, who also erected the monuments.

RIVER ST. JOHN.

The survey was made by two parties from each Commission, acting in pairs; one of each Commission surveying in company.

ST. FRANCIS.

The survey was made by a party from each Commission.

SOUTH-WEST LINE.

The tracing and marking of this line was executed by the British Commission alone; but the work was examined and verified afterwards by the American Commission.

SOUTH LINE.

The same as on the South-West Line.

SOUTH-WEST BRANCH OF THE ST. JOHN.

The survey was made by the American Commission, verified and marked by the British.

HIGHLANDS.

From the source of the South-West Branch to the Kennebec Road the dividing ridge was sought out, and a succession of summits fixed, by a party from each Commission. The cutting of the Boundary was done by the American Commission; and the survey afterwards was made by a party from each Commission, but not acting together.

The erecting of the monuments was performed by the British Commission.

From the Kennebec Road to the source of Hall's Stream, the dividing ridge was sought out and summits fixed by the British Commission; but it was verified afterwards by the American Commission, and a chain of summits was also erected by it.

The cutting of that portion of the Boundary was executed by the British Commission.

The survey was made by both Commissions; but their parties did not act together.

The hauling of the monuments to their places during the winter was performed by the British Commission from Hall's Stream to the Kennebec Road, and from thence to the source of the South-West Branch by the American Commission.

The erecting the monuments afterwards was done in part by the British and in part by the American Commission.

HALL'S STREAM.

The survey was by a party from each Commission, acting together. The marking was undertaken by the American Commission.

WEST LINE.

The exploration was done by the American Commission, verified by the British.

The cutting of the Boundary was executed by the Americans alone.

The survey was made by each Commission, but not acting in company.

Appended to this narrative will be found reports from Captain, now Major Robinson, and the late Captain Pipon, to the British Commissioner, relating to the astronomical operations entrusted to them, which have been already mentioned in the foregoing narrative; but they will be found more in detail in the accompanying reports.

(Signed) J. B. BUCKNALL ESTCOURT, Lt.-Col.,
Estcourt, December 31, 1847. H. M. Commissioner.

REPORT OF CAPTAIN ROBINSON TO LIEUTENANT-COLONEL BUCKNALL ESTCOURT.

Washington, United States, July 7, 1846.

I ANNEX to Captain Pipon's Report a statement of the rates of those chronometers which were under my particular charge, with some remarks on our proceedings generally; and also some observations and results of signals which were made for the determination of differences of longitude between my station at Lake Memphramagog and those of Major Graham, of the United States' Topographical Engineers, at Rouse's Point, and Lieutenant Thom, of the same corps, stationed at Richford.

The chronometers supplied to us from Greenwich consisted of four box chronometers, regulated to sidereal time, and seven pocket chronometers, regulated to mean time.

From Greenwich to Liverpool they were conveyed by railway, and from Liverpool to the Grand Falls, in New Brunswick, where our operations on the Boundary Line commenced, they were conveyed by water, the only exceptions being the short land-carriages from the ship to the hotel, and thence to the next vessel or boat by which the party was to proceed. No accident, or any rough travelling, occurred to affect them on their journey.

At the Grand Falls an equal partition of them was made, as under:—

CAPTAIN ROBINSON.

Box chronometer,	No. 2277,	by Parkinson and Frodsham.
———	51,	by Heyes.
Pocket chronometer,	3147,	by Molyneux.
———	3091,	by Molyneux.
———	2187,	by Arnold.

CAPTAIN PIPON.

Box chronometer,	No. 341,	by Arnold.
———	2,	by Frodsham.
Pocket chronometer,	3148,	by Molyneux.
———	3226,	by Molyneux.
———	3227,	by Molyneux.

The seventh pocket chronometer, No. 2111, stopped frequently at the winding up, however carefully done; it could not be depended on, and was therefore never made use of in any of our calculations.

Our instruments were two portable transits of thirty inches focal length; a third of smaller size; two altitude and azimuth instruments, one of 15-inch, the other of 12-inch vertical circles; two mountain barometers (by Simms), and six French, or Gay Lussac barometers, with other minor instruments, such as sextants, azimuth compasses, &c. These were pretty equally divided between the two astronomical parties.

There was also one large telescope of 42-inch focal length, for observing occultations, eclipses of Jupiter's satellites, &c., which was transferable between us as occasion required.

The duties which devolved upon Captain Pipon and myself were to determine the latitudes and longitudes of as many points along the Boundary Line as might be necessary to make a correct map of it, and to serve as points between which the surveyors could adjust and adapt their surveys.

A triangulation along the Boundary was quite impossible.

Another and principal object was to determine the directions, and run two straight lines of boundary, one of sixty-four miles long, the other of about twenty, between certain given points which had been fixed upon by the Treaty of Washington.

Owing to the impracticable nature of the country, this could only be done by ascertaining very accurately the latitudes and difference of longitudes of the points, and then calculating their bearings with the meridian.

The plan of operations adopted to obtain these objects was for us to take up stations at short distances apart, between which a communication could be obtained within a moderately short period of time, not exceeding two to three days, and during which the rates of the pocket chronometers could be trusted while travelling from one standard to the other. The difference of longitude between every station was thus determined by interchanges of chronometers, or in some cases by signals. The latitude was at the same time determined by observing altitudes of stars when on and near the meridian.

Commencing at the Grand Falls near the eastern limit of the Boundary in New Brunswick, and proceeding westward, a chain of stations was formed from it to St. Regis, the western extremity of the Boundary Line, connecting the whole in longitude from one end to the other,—a line of boundary of some 600 miles in extent.

The parties reached the Grand Falls in June, 1843, and Captain Pipon proceeded immediately to the mouth of the Madawaska River, and established his first station at a distance up the River St. John of about forty miles from the lower station at the Grand Falls.

A transit instrument was set up at each station, and observations for time were commenced on the 1st of July. The communication was by water; each party had three boats and six boatmen attached to it. As soon as possible, after obtaining a good night's observations, the pocket chronometers were compared with the standard chronometer, and sent off to be compared with the standard at the other station, and then immediately returned, to be again compared with the first standard.

Three transmissions in this way of each officer's set of pocket chronometers from any two stations, were generally deemed sufficient to give a good difference of longitude between them.

When the difference of longitude between the Grand Falls and the mouth of the Madawaska was considered to be satisfactorily determined, the party at the Grand Falls moved up the river, passed Captain Pipon's station, and took up a position at the mouth of the River St. Francis, some forty miles distant from it.

The River St. John, along the course we had to follow, is full of shallows and rapids, and the ascent against the stream is laborious and slow. The distances, therefore, at which our stations were taken up were necessarily at short distances from each other. The average distance the first season was forty miles, and it sometimes took us as much as sixty hours to perform even so short a journey as this. The same number of interchanges, viz., three each, were made between the St. Francis and the mouth of the Madawaska. Captain Pipon then passed up the River St. Francis, and took up his station at the outlet of the Lake Pohenagamook, at the point where the Boundary was to quit the line of the river, and take a direct course across the country of sixty-four miles, to a point on the north-west branch of the River St. John.

Interchanges were made between the mouth of the St. Francis station and the outlet of the lake, in the same way as at the other stations.

To communicate from one end of the sixty-four miles to the other end, across the country, was quite impracticable; and to obtain the difference of longitude between the extremities of this line, it was necessary to take up two intermediate stations on the St. John.

Captain Pipon therefore moved from the outlet of the Lake Pohenagamook, passed down the St. Francis and up the St. John, establishing himself at the mouth of the Great Black River. The usual interchanges were made between this and the St. Francis; and the party at the latter moved up to a station near the Forks of the St. John, at the southern extremity of a line which had been cut through the woods by one of the surveying parties, to establish the point on the North-West Branch, which by the Treaty was to be ten miles distant in the nearest direction from the main River St. John.

Up to this period all the chronometers had gone well, and the results obtained from them appeared quite satisfactory. At the end of October a great change in the temperature took place. The party moving up to the Forks had to break their way in some places through ice. Snow fell and remained on the ground, and all communication for some time was cut off with the party at Black River.

During the months of November, December, and January, the cold was intense. The thermometers brought from England would only register to $-19°$ of Fahrenheit. The column of mercury was frequently all in the bulb, and the degree of cold must have been very much greater than $-19°$. Judging from reports of its intensity in other portions of Canada, where it was registered, it must have been at times beyond $-30°$.

The chronometers during this time were kept in a log-hut, in which a stove was necessarily used. They were placed in a deal box, packed round with horse-hair, and the box itself wrapped up in a large blanket, to keep the temperature as even as possible. In the day-time the room was kept at a temperature of 60° of Fahrenheit, whilst at night, when the fire could not be prevented from going out, the temperature would sink to very nearly the $-19°$ point. This great and sudden range of temperature was necessarily very trying, and affected them sensibly. The standard, No. 2277, once stopped at the winding-up for 1m. 16·5s., which it had never done before; and its average rate increased from 0·40s. to 2·63s. During the expedition, both before and after these months, this chronometer performed very well.

No. 51, Heyes, rate increased largely, from $-4·82$s. to $-7·17$s. At other times its rate was tolerably constant, though large; on which account, and because it beat 130 times to the minute, the first opportunity (which occurred in the following winter) was taken to send it to England, and have it exchanged for another. In the course of one night in November three pocket chronometers stopped from the intense cold.

No. 3091 was particularly affected. Whilst kept warm it would go, but if taken into the observatory it would stop directly.

No. 2187 was moderately affected. This chronometer performed very fairly throughout.

No. 3147 was the least affected. It performed well during this winter, and very well indeed at all other times.

No. 3091 was taken to England in December, 1844, and placed in the maker's hands. It improved it for a time, but its performance in 1845 was always doubtful.

In January, 1844, the River St. John became frozen over throughout, and interchanges of chronometers were made with the mouth of the Black River by means of carioles,—a light kind of sleigh.

In this case there was a slight variation in the plan of interchanging. Early in November, Captain Pipon had sent up his pocket chronometers to the Forks, for a first interchange by water on the usual plan; but the river partially freezing over, the men were obliged to abandon their boat on their journey when near the Forks, and the chronometers in consequence could not be returned to him.

In making the interchanges, the pocket chronometers were all sent together from one station to the other; going and returning three times from the Forks to the Great Black River, and twice from the Great Black River to the Forks and back.

Notwithstanding the very unfavourable circumstances under which this difference of longitude was obtained,—the observations being made sometimes when the mercury had sunk into the bulb of the thermometer,—the spirit in the levels of the instrument condensed so much that occasionally only one end of the bubble could be seen, and that it was painful to touch any kind of metal without gloves on,—yet the ranges were not on the whole greater, nor did the results appear less satisfactory, than those made in warmer weather.

There was still a link necessary in the chain to obtain a difference of longitude and latitude between the two ends of the Sixty-four-mile Line. This was the bearing and exact distance of the North-West Branch Point from the station at the Forks. This was obtained by observation and measurement along the line mentioned as having been cut by a surveying party in the summer.

It was not until the end of January that, by this indirect and tedious course, the differences of longitude and the latitude of the two ends of the line were determined.

From the data thus obtained the bearing of the line from each end was calculated. The chief object in view in thus persisting to carry on observations during the severity of a Canadian winter, was to obtain these data in time to run the line through the woods in the spring of the year, whilst the snow was yet on the ground and the rivers still frozen over, enabling provisions and camp equipments for the cutting parties to be carried along with greater facility than at any other time.

The beginning of March was the time decided upon to commence running the line.

Captain Pipon, by a circuitous route, taking with him a party of labourers, went back to his former station at the outlet of the Lake Pohenagamook, made his observations to lay off the direction of the line according to the calculation, and commenced cutting.

The party at the North-West Branch end (including Lieutenant-Colonel Estcourt and Mr. Scott, with a strong body of labourers) did the same, and commenced cutting from their side.

About four miles from the North-West Branch end, the line passed over the shoulder of a conical-shaped hill, called the Sugar-Loaf, from which there was a good commanding view of the country for many miles in the direction the line was to take.

The transit instrument was removed from the North-West Branch to an elevated stand and platform made for it on this shoulder of the hill. At the starting point a light was burnt nightly; the transit instrument was set upon it; and being then turned on its axes, the true direction of the line in continuation was easily and accurately ascertained. The party, for the sake of convenience, encamped not far from the instrument stand, the snow on the ground being at the time everywhere about four feet deep. Mr. Scott, with a strong body of labourers—for it was necessary to cut a way for themselves through the dense forest, and to carry provisions—set off from Sugar Loaf Hill to the first succeeding ridge, about four miles distant, which having reached, he halted and waited until night; when, by signals previously agreed upon, the point on the hill where the line passed was marked, a clearing made round it, and a pole set up. After doing which, he set off for the next succeeding ridge, upon which a view back of the Sugar Loaf Hill could be obtained, steering and cutting his way across the valleys as well as he could by the compass.

The plan of getting into line was thus: having arrived on a ridge, from which the Sugar Loaf (a very conspicuous object) could be seen, a torch-light made of the bark of the birch-tree was burnt as soon as it was dark. A torch made of this bark gives a most powerful light, which could be distinguished easily at the greatest distance we had occasion to use them—this was about thirty-eight miles. As soon as the torch was seen from the transit-stand, the instrument was levelled, turned upon the light burning at the starting point, and then reversed in the direction of the cutting party, when it was at once seen how much they had got out of the right line.

The signals employed were flashes of gunpowder, the quantity used varying from two charges of a fowling-piece up to seven or eight per flash, according to the distance.

The instrument being levelled and ready, four flashes were fired in quick succession, to denote the same to the cutting party.

This being answered by an equal number from them, denoting their readiness also, the signalling was continued:—

One flash—move north.
Two flashes—move south.
Three flashes—wait awhile.
Four flashes—the torch is in the line. Proceed on to the next station.

To prevent mistakes, and keeping one party waiting unnecessarily for the other, it was customary to acknowledge every signal made, immediately, by a corresponding signal.

Flashes by gunpowder fired at night are very effective signals, far superior to rockets. They are instantaneous, and can be seen at very great distances. At forty miles they were seen distinctly, whilst rockets were made out with difficulty, and sometimes not at all. When a point in the line was determined, clearings were made round it, and a cutting made towards the Sugar Loaf Hill, and continued some way in the contrary direction. These formed notches or gaps, which were conspicuous in the day-time, and served as a guide to the cutting party to take up their next position pretty accurately. Heliostats by day were also used for keeping the line. Proceeding in this way, points in the line, crossing ridges of hills, were marked at eight several places, the last being about thirty-eight miles distant from the transit instrument at the Sugar Loaf. The ground beyond this, on the other part of the line, was very unfavourable for the Pohenagamook party, affording no commanding station, and the transit had to be moved from station to station.

It was not until the end of five weeks, during which time the two cutting parties had been constantly approaching each other, that any intelligence or symptoms of their contiguity were obtained.

At the end of this time, the North-West Branch party, cutting their way onward, descried trees falling upon the ridge to which they were advancing, and gradually a notch or gap appeared. This was the Pohenagamook party, and apparently right in the place for which the others were making.

The direction of each line was, however, continued until they came abreast of each other, when the distance from one to the other was measured, and found to be 341 feet;—an amount equal to what would be produced by about one-quarter second of time error in the determination of the difference of longitude of the two extremities of the line.

Each party as they proceeded cutting their way measured as well as they could the distances they had advanced, and of those points at which marks in the line had been set up. This 341 feet was divided proportionally, according to the distance each party had made from their starting points. A high pole or staff was erected at the spot thus given, and the two cutting parties, turning their backs upon each other, set off on their return back to their original stations.

At each former point, where a mark had been set up, an offset was measured from it, proportionally to its distance on the line, a place cleared for it, and a new pole prepared to be set up to mark where the correct line should pass. The transit instrument on the Sugar Loaf, four miles distant from the North-West Branch end was shifted its proportional distance also, and as the cutting party returned homewards, signalled them at night into line on each succeeding ridge. The cutting of this line commenced about March 10, 1844. The parties came in sight of each other for the first time on the 17th of April following, and the distance between the two lines, when abreast of each other, was measured about the 20th of April, making a period of forty-one days' cutting from the starting points. At the commencement the snow was four feet on the ground, and the rivers everywhere frozen over, but before it was concluded the snow had begun to melt away, and the rivers were running in torrents. Great difficulty was found in keeping up the communications and supplies of provisions. Carrying loads through the woods: under favourable circumstances the men could not make more on an average than eight to ten miles a day. At one period on this line a party of labourers sent with provisions could not make more than four to five miles through the soft and melting snow, in which snow-shoes were worse than useless.

Further operations were pretty much suspended until the beginning of June, when strong parties of labourers, directed by non-commissioned officers of the Sappers and Miners, were sent to cut out the whole line thirty feet wide, clearing a way in the centre, of about eight feet wide, but leaving the other part with the stumps breast-high, and the trees as they had fallen. These parties were guided in their cuttings by the marks which had been set up on the ridges at no very great distances apart from each other. When the line had been thus cut out from end to end, a transit instrument was sent through it, adjusting correctly all the station-poles, and insuring the straightness of the line beyond all doubt.

This having been finally accomplished, the next proceeding of the astronomical parties was to run another straight line, but of shorter length (being not quite twenty miles), between the North-West Branch station and a point on the South-West Branch of the River St. John, where the stream was intersected by the parallel of 46° 25′ of north latitude.

In June Captain Pipon proceeded up the South-West Branch, and after one or two trial latitudes, took up a position within a few seconds of the true point, which was afterwards determined from it accurately by measurement.

Interchanges of chronometers were made in the usual way between this station and that at the North-West Branch end.

The communication (though rather circuitous by water) was made from end to end direct, that is, without any intermediate station. Three trips of the chronometers were made each way. With the difference of the longitude thus determined, and the absolute latitudes, the direction of the line from each station was computed, and it was proceeded with to be cut and run much in the same way as the longer line had been.

It was not, however, quite so successfully done, the lines proving, when they were abreast of each other, to be 576 feet apart—a quantity denoting an error of one-half second of time in the determination of the difference of longitude of the two extremities.

As this had been obtained so much more directly than in the preceding case, too much confidence was placed in the result given by the trips of the chronometers, and it would have been better had a greater number of them taken place. This error was divided proportionally to the distances each party had cut from their starting points; the marks set up at the intermediate stations shifted; the line adjusted, cut out thirty feet wide with eight feet clear in the centre, and was finally tested by sending a transit instrument through from end to end.

At the beginning of September, 1844, these operations were all completed, and the next step in the order of proceedings was to obtain a difference of longitude be-between the station at the North-West Branch and Quebec. The actual distance in a straight line from one to the other was something more than sixty miles. The communication was by land, and the road of the worst description for the transmission of chronometers: they could not escape being very much shaken; the time of absence on their journey to and fro would necessarily be of some duration; and any very accurate result by the usual plan of interchanges could scarcely be expected. Signals from an intermediate hill were therefore adopted. At all times the latter plan is the simplest and most accurate way of determining a difference of longitude, and would have been adopted before, had any opportunity of doing so presented itself. From the top of a hill a little more than a mile distant from the North-West Branch station, a range of hills could be seen about twenty miles off, in the direction of Quebec. This it was conjectured, and rightly, would be seen also from Quebec.

Captain Pipon and his party, therefore, leaving the woods, proceeded to Quebec, and established his transit instrument at a station on the Plains of Abraham, from whence there was the best view in the required direction. The transit instrument at the North-West Branch, and chronometers, were removed to the Lake Hill station. Serjeant McGuckin, of the Royal Sappers and Miners, with a party of labourers to assist him, was sent to one of the most conspicuous hills on the range, taking with him a tent, provisions, a supply of gunpowder, rockets, pulleys, rope, &c. This whole range was covered to the summit with a dense mass of forest.

From the Lake Hill a heliostat was kept at times reflecting to the hill selected, as a guide to Serjeant McGuckin in choosing the right one. Having arrived at the hill, and ascertained by climbing, that he could see back to the Lake Hill, and forward in the direction of Quebec, the labourers were set to work to make a clearing on the top, leaving one tree in the centre, from which the flashes were to be fired. These were thus managed:—

The leaves and branches of the tree which were in the way were cut off; a small pulley, with an endless rope through it and reaching to the ground, was attached to one of the top branches; a piece of tin was rolled up so as to form a small conical cup, and attached with wire to the endless rope; the charge, varying from a quarter to a half of a pound of gunpowder, was wrapped in a piece of paper and placed in the tin cup, with a certain length of touch-paper hanging out of it. The end of this being lighted, the tin cup was hoisted quickly by the rope to the top of the tree, where the charge exploded, and the cup was hauled down again. Serjeant McGuckin had a pocket chronometer with him, by which he was directed to fire his charges, at ten-minute intervals, between 8 and 10 o'clock every evening, after it was known that the Quebec party were ready to commence observations.

As soon as this was known at the Lake Hill, a signal to that effect was made to him, and the flashing commenced.

Previous to commencing with the flashes, two rockets were fired from the hill, and at the termination one or two more. It was found difficult to note the precise moment of their bursting; some were not seen, and no use was made of them in the calculations.

Transits of stars were observed for time on the same night that the signals were made, and the ten-minute intervals allowed it to be done with but little interruption from them.

On the night of the 23rd September (the first night), out of thirteen fired, ten flashes were observed and noted by both parties. From Quebec the distance must have been fully forty miles, yet they were distinctly visible, even to the naked eye. The signals were repeated on five subsequent nights, with various success as to the numbers noted in common.

Some of the nights the wind blew strong, and the charges exploded before reaching the top of the tree. In the course of six nights forty-six observations in common were observed, and this number was deemed sufficient to give a good difference of longitude. Compared with what was obtained afterwards between other stations, the ranges on this occasion were great, but at that time they were thought by us very good. The observatory tent on the Lake Hill was much exposed, and the lights were not so well protected from the high winds as could have been desired, and had some effect, no doubt, on producing the high ranges. When the signalling was over, the experiment was tried of sending the pocket chronometers for one trip, from the Lake Hill to Quebec and back. The time on their journey was four days and eight hours; the road travelled of the worst description. For more than half the journey they were carried by a man on foot, the other portion in a cariole. The mean of the three chronometers thus sent gave a result differing by two and a half seconds of time from that obtained by the flashes. The same was tried by one interchange from Quebec to the Lake Hill and back, but that proved an entire failure, and no more trials were made.

On the 21st October the Lake Hill party left the woods with the intention of proceeding to Montreal and forming a station there, to be connected with that at Quebec by the usual interchanges of chronometers.

Passing out of the woods by the way of St. Thomas, the party arrived at Montreal on the last day of October.

Winter had now commenced; the ground was covered with snow, rendering it difficult to select a good spot on which to set up the instruments, and as the navigation between Montreal and Quebec generally closes in the month of November, it was not probable that the two stations could be connected before the communication was broken up. The field operations for the year 1844, so far as the astronomical parties were concerned, were therefore terminated.

At Quebec, however, where a good and substantial observatory had been set up, observations for absolute longitude, by lunar transits and moon culminating stars, continued to be made through the winter, whenever opportunities offered.

From June 1843 to the end of October 1844, the astronomical parties had been engaged, with only the intermission of part of the month of February and part of the month of May, in the constant prosecution of their particular duties. From the impracticable nature of the country, the bad communications, and the necessarily rough means of transport by small boats and canoes on the rivers, and men's backs in the woods, some damages and breakages could not be prevented to our instruments.

One mountain barometer and three of the smaller (Gay Lussac) barometers were by this time broken.

One of the box chronometers (51 Heyes) had suffered, and it was desirable to exchange it for another. No. 3091 pocket chronometer had failed entirely about this time. An improvement in one of the transit instruments was desirable, and some other repairs to the smaller instruments were required. There were no means of effecting these in this country.

The winter afforded a favourable opportunity of getting all set to rights again and ready for the next year's operations; and, having obtained leave, they were taken to England by me in December 1844, and brought back to Montreal in time for the recommencement of observations at the first opening of the navigation of the St. Lawrence.

This was the 28th of April, 1845.

Pursuing the plan of operations, of connecting the eastern with the western termination of the Boundary by a chain of stations at moderate intervals apart from each other, a site was selected on St. Helen's Island, opposite the city of Montreal. Two stone pillars, standing upon good foundations, had, in the course of April, been prepared for the instruments, and observations and interchanges of chronometers with Quebec were immediately commenced.

The distance between these two stations is the greatest in our chain; but the communication by the large steam-boats running on the St. Lawrence rendered it the easiest, and the interval in time among the shortest.

Four interchanges were made by each party; the results appeared very satisfactory, agreeing closer together than they did on any other occasion.

	M.	S.
The mean difference of longitude by four sets of Captain Pipon's chronometers was	9	17·80
Do. four sets of Captain Robinson's was	9	17·67
Difference . . .	0	0·13

The distance was the greatest, the time of absence was the same as some of the others; but the transport or carriage of the chronometers was the easiest of all the stations.

These interchanges occupied the month of May. The Quebec party then moved up to St. Regis, the western termination of the Boundary

During the interval of establishing the observatory there, the opportunity was taken of making interchanges with Major Graham, of the United States' Topographical Engineers, who had taken up a position (for astronomical observations) on the Boundary at Rouse's Point, on Lake Champlain. Three trips of chronometers were made from St. Helen's to Rouse's Point and back, and four of Major Graham's from Rouse's Point to St. Helen's and back.

The St. Regis party being by this time ready, interchanges between it and St. Helen's commenced; four journeys of the chronometers each way were made in the usual manner.

This completed the junction of the Grand Falls by differences of longitudes with St. Regis.

There appearing a very favourable hill for connecting St. Regis with Rouse's Point by signals, it was suggested by Captain Pipon to do so, and carried into effect very successfully.

	M.	S.
By observations made on five nights, during which eighty-two flashes were observed in common, the difference in longitude was made to be	5	13·24
By transmission of chronometers between St. Helen's and St. Regis, and St. Helen's and Rouse's Point, the difference of longitude was made to be	5	13·12
Difference . .	0	0·12

A difference of only twelve-hundredths of a second of time, showing how very accurately the transmission of chronometers would give a difference of longitude when the communications were easy.

In July the party at St. Helen's broke up, and moved to a point on the Boundary Line where it crossed the Lake Memphramagog on its eastern shore, the object being to determine its latitude and the difference of longitude between it and Rouse's Point.

A high mountain in Vermont, called Jay Peak, situated intermediately and a little to the south of the line, afforded a very favourable opportunity of connecting the stations by signals. The distance between the two stations was in a straight line about fifty-six miles.

Corporal Forbes, of the Royal Sappers and Miners, was sent with a party of labourers, and encamped near the top of the hill from which the signals were to be made.

The hill was high, and bare of wood at its summit; no clearing or especial contrivance was necessary. He was supplied with a chronometer watch to regulate his times of firing.

The charges varied from a quarter to one-third of a pound of gunpowder, fired from the surface of a piece of flat board. At first the intervals between the flashes were fired at ten minutes, beginning at 9 and ending at 11 P.M., but were changed to three-minute intervals, and fired between half-past 8 and half-past 9 P.M.; and the observations for time (which it was always desirable to have on the same evening) were made when the signalling was over.

The flashes were fired only on fine nights, and could be distinctly seen from both stations. In the course of six nights' signals, eighty flashes were observed in common.

Corporal Forbes's party was relieved on the 19th of August, and was succeeded by an American party, who continued the signals in the same manner; but the interval between the flashes was reduced to about two minutes, and the time of signalling to between 8 and 9 P.M.

Whilst the signalling was in progress between the station at Lake Memphramagog and Rouse's Point, Lieutenant Thom, of the United States' Topographical Engineers, took up a station for astronomical observations on the Boundary at Richford, about twenty-four miles distant from Lake Memphramagog and thirty-two miles from Rouse's Point.

The Jay Peak could be seen from his station, and the signals made from it answered for the three parties.

In the course of six nights' observations, ninety-five flashes were observed in common with Richford, and the difference of longitude obtained by the whole was 1m. 53·72s.

	M.	S.
The highest result of any one night's observations was . .	1	54·11
The lowest	1	53·33
The range . .	0	0·78

Between Lake Memphramagog and Rouse's Point, by eighty flashes and six nights' observations, the difference of longitude was made 4m. 35·08s.

	M.	S.
The highest result of any one night's observations was . .	4	35·55
The lowest	4	34·50
The range . .	0	01·05

Between St. Regis and Rouse's Point, the mean of eighty-two flashes, observed on five nights, gave a difference of longitude of 5m. 13·24s.

	M.	S.
The highest result of any one night's observations was . .	5	13·64
The lowest	5	12·75
The range . .	0	0·89

For the sake of experiment, and testing the result by transmissions of chronometers, one trip was made from Lake Memphramagog to Rouse's Point and back, and one to Richford and back.

	M.	S.
By the signals, Rouse's Point was west	4	35·08
One trip of three pocket chronometers gave it	4	35·55
Difference . .	0	0·47
By signals, Richford was west	1	53·72
One trip, three pocket chronometers gave it	1	54·65
Difference . .	0	0·93

These results agreeing so well were considered highly satisfactory.

From the commencement of observations at the Grand Falls, to their conclusion at Lake Memphramagog, observations for absolute longitude by lunar transits and moon culminating stars were made at every station, whenever a favourable opportunity offered. Thirty-nine lunar transits were obtained at Quebec alone; thirty-nine were obtained at the stations east of Quebec; and twenty-one at stations west of Quebec: in all ninety-nine observations.

These have all been corrected for lunar errors by data received from Greenwich.

Referring them all by means of the ascertained differences of longitude to the one station at Quebec, an absolute longitude for Quebec has been derived from a mean of ninety-nine observations of transits of the moon's bright limb.

The result given by them is, that the longitude of the astronomical station at Quebec is 4h 44′ 42″ west from Greenwich. From this and the known differences of longitude between it and each of the other stations, their absolute longitudes are determined, and given in the accompanying abstract.

This result for Quebec differs by several seconds from the determinations of other observers, and it will be advisable, therefore, on our return to England, to have the calculations all carefully examined or recalculated.

It may then probably become necessary to add a certain fixed quantity to each of the determinations given in the abstract.

The observations at Lake Memphramagog occupied all August and part of September 1845. It was next intended that Major Graham should connect a station at Canaan Corner (the eastern extremity of the Boundary following the 45th parallel of latitude) with the Lake Memphramagog; but, being detained longer than was expected at Rouse's Point, the intention was not carried out.

This terminated the astronomical observations and labours in the field of the officers on the British Commission. The party broke up and moved from Lake Memphramagog early in October 1845, and proceeded to join the other members of the Commission, who had preceded them to Washington in the United States, where the time since has been occupied in examining the observations, revising the calculations, and in making out fair copies of the whole, to accompany the plans and reports of the Commissioners.

(Signed) WM. ROBINSON, Capt. R.E.

Note.—The observations and calculations for the absolute longitudes were, upon the return of the Commission to England, submitted for the examination and opinion of Mr. Airy, the Astronomer Royal at Greenwich, who, after a careful consideration and a recalculation of the lunar transits with every improved data that could be supplied by the Observatory at Greenwich, determined the result of the absolute longitude of the astronomical station at Quebec to be 4h 44′ 43·91″ west; therefore a correction of 1·91″ of time, or 28·65″ of arc, must be added to every absolute longitude in the General Abstract attached to this Report.

London, April 11, 1847.

(Signed) WM. ROBINSON, Capt. R.E.,
Bt. Major.

Note.—It should be borne in mind, whilst considering the performances of the chronometers, as shown by the accompanying Tables, that perhaps on no expedition were chronometers more severely tried than on this of the Boundary Commission. They were necessarily kept in tents or log-huts heated by stoves; they were exposed to the extreme heat and cold of a Canadian climate; and were constantly being moved from one station to another. Whenever the opportunity offered, they were carried by water, but frequently they had journeys to make by land, and were conveyed in the carriages of the country over very bad roads, and sometimes they were carried by hand through the woods.

W. R.

Sidereal Chronometer, Parkinson and Frodsham, No. 2277 (Box Chronometer) used as standard.

Station.	Date.	Rates. Range during month. From	Rates. Range during month. To	Average or mean of Rates determined during the month.	Remarks.
	1843	s.	s.	s.	
Greenwich . .	April .	+0·1	−1·1	−0·5	
On passage out .	April .	...	...	−1·57	On board steamer "Hibernia."
Grand Falls, New Brunswick.	July .	−0·00	−2·89	−1·66	Chronometer kept in a tent.
Mouth of River St. Francis.	Aug. .	−0·99	−2·50	−1·49	Kept in a hole in the ground made under the floor of the observatory.
Ditto	Sept. .	−0·54	−1·82	−1·11	
Ditto	Oct. .	+0·08	−0·80	−0·40	
Forks of Saint John.	Nov. .	−1·24	−4·57	−2·63	A great change in the temperature this month.
Ditto	Dec. .	−1·60	−2·88	−2·28	Subject these months to great and sudden changes of temperature, varying from 60° of Fahr. to some unknown quantity below −19°, at which point the mercury was in the bulb.
	1844				
Ditto . .	Jan. .	−0·05	−3·44	−2·17	
N. W. Branch .	March.	−0·58	−1·69	−0·76	On 9th January, stopped at winding up, 1m. 16·5.
Ditto	July .	+1·07	−0·30	+0·03	April, May, and June, no observations for time; engaged tracing and cutting out the 64-mile line.
Ditto	Aug. .	+0·07	+0·36	+0·21	
Ditto	Sept. .	+0·33	+0·41	+0·37	
Lake Hill . .	Sept. .	−0·46	−1·30	−0·94	Moved to a new station. Changed the rate from gain to loss.
Ditto	Oct. .	−0·86	−1·82	−1·27	Operations for the season terminated in October.
	1845				
Saint Helen's Island, near Montreal.	May .	+2·38	−2·10	−0·21	Not used as standard during these three months. Temperature very great, part of June and July.
Ditto	June .	+2·57	−1·95	+0·40	
Ditto	July .	+2·81	−0·84	+0·41	
Lake Memphramagog.	Aug. .	+1·40	−1·98	+0·08	Kept in a tent (under ground).
Ditto	Sept. .	−0·63	−3·67	−2·16	Operations in the field; observations terminated in September, 1845.

SIDEREAL CHRONOMETER No. 51, HEYES (BOX CHRONOMETER).

STATION.	Date.	Rates. Range during month. From	To	Average or mean of Rates determined during the month.	REMARKS.
	1843	s.	s.	s.	
Greenwich . .	April .	—5·3	—3·3	—4·0	Rated at the Royal Observatory.
Atlantic Ocean .	April .	...	...	—3·65	On board the "Hibernia" steamer.
Grand Falls, New Brunswick.	July .	—2·77	—7·50	—4·11	Observations for time commenced this month.
Mouth of River St. Francis.	Aug. .	—3·74	—6·74	—4·48	Kept under ground in observatory tent.
Ditto	Sept. .	—3·59	—5·82	—4·75	
Ditto	Oct. .	—4·12	—5·62	—4·82	
Forks, River St. John.	Nov. .	—9·60	—4·78	—6·28	Kept in a log-hut heated by stove. The variations of temperature during these three months were sudden and great; the thermometer varying from 60° during the day to some unknown quantity below – 19° of Fahr. at night.
Ditto	Dec. .	—8·96	—5·88	—7·17	
	1844				
Ditto	Jan. .	—9·12	—4·05	—6·88	
					February, no observations for time.
N. W. Branch .	March.	—6·77	—3·51	—4·77	April, May, and June, no observations for time; engaged running and cutting out the 64-mile line, &c.
Ditto	July .	—2·59	—5·30	—4·10	
Ditto	Aug. .	—3·43	—5·54	—4·40	
Ditto	Sept. .	—3·14	—5·09	—4·38	
Lake Hill. . .	Sept. .	—5·96	—4·80	—5·32	Removed to Lake Hill, 19th September.
Ditto	Oct. .	—6·10	—4·55	—5·17	Operations in the field closed for the season, October, 1844.

On the 21st of October, the chronometers were taken from the Lake Hill to St. Thomas, and from thence to Quebec and Montreal. This chronometer beat 130 times to the minute; on which account, and its large rate, Captain Robinson took it to England with him in December, 1844, and exchanged it for Sidereal Chronometer No. 943.

(Signed) WM. ROBINSON,
Captain Royal Engineers.

Chronometer No. 943, Molyneux (Sidereal Box Chronometer).

Station.	Date.	Rates. Range during month. From	To	Average or mean of Rates determined during the month.	Remarks.
					No. 943 was brought from England in April, 1845, in exchange for 51, Heyes.
	1845	s.	s.	s.	
St. Helen's Island, Montreal.	May .	+0·03	—1·45	—0·73	Used as standard chronometer for these three months.
Ditto	June .	—1·30	—2·56	—2·13	
Ditto	July .	+0·13	—5.23	—3·30	In July the temperature increased considerably, and the chronometer rate increased with it.
Lake Memphramagog.	Aug. .	—2·86	—12·01	—7·60	Kept under ground under the floor of a tent.
Ditto	Sept. .	—14·10	—7·55	—10·10	The temperature during these months was very high.
					Operations in the field and observations terminated September, 1845.

Pocket Chronometer No. 3147, by Molyneux.

	1843				
Royal Observatory, Greenwich.	April .	...	...	+1·3	
Atlantic Ocean .	April .	...	...	—0·14	On board steamer "Hibernia."
Grand Falls, New Brunswick.	July .	+0·34	—1·16	—0·23	Travelling repeatedly from one station to another for determining difference of longitude.
Mouth, River St. Francis.	Aug. .	—2·33	—1·46	—1·73	
Ditto	Sept. .	—2·05	—0·02	—0·87	
Ditto	Oct. .	+0·38	—3·52	—1·81	
Forks, River St. John.	Nov. .	—3·7	—1·64	—2·85	Exposed to great variations of temperature these months.
Ditto	Dec. .	—2·38	—3·14	—2·74	
	1844				
Ditto	Jan. .	—1·99	+0·11	—0·86	Ditto, and travelling for difference of longitude.
N. W. Branch .	March .	—1·78	+2·04	+0·77	
Ditto	July .	—0·18	—3·05	—1·06	
Ditto	Aug. .	—2·70	—0·11	—1·53	
Ditto	Sept. .	—0·43	—1·12	—0·84	Removed to Lake Hill, 19th September.
Lake Hill. . .	Sept. .	+0·27	+4·67	+2·63	
Ditto	Oct. .	+0·17	—1·07	—0·45	
	1845				
St. Helen's Island.	May .	+2·19	—1·61	+0·51	Travelling constantly for difference of longitude.
Ditto	June .	—0·44	+0·84	+0·42	Ditto.
Lake Memphramagog.	Aug. .	+1·15	—1·38	—0·30	Kept under ground under floor of tent.
Ditto	Sept. .	—0·98	+2·65	+0·38	

Pocket Chronometer No. 3091, by Molyneux.

Station.	Date.	Rates. Range during month. From	To	Average or mean of Rates determined during the month.	Remarks.
	1843	s.	s.	s.	
Royal Observatory, Greenwich.	April .	...	...	—2·1	Removed from Greenwich, 16th April.
On passage out .	April .	...	...	+0·7	On board steamer "Hibernia."
New Brunswick, Grand Falls.	July .	+0·96	+ 2·26	+1·53	Travelling constantly to and fro for determining difference of longitude.
Mouth of St. Francis.	Aug. .	+0·26	+ 0·80	+0·58	
Ditto	Sept.	+0·35	+ 1·62	+0·99	
Ditto	Oct. .	+1·35	—12·14	—2·29	
Forks of St. John.	Nov. .	...	...	...	During these four months this watch stopped whenever exposed to the cold, and no dependence could be placed upon its rates. As long as kept warm, it would go, but not otherwise.
Ditto	Dec. .	...	...	...	
	1844				
Ditto	Jan. .	...	...	...	
N. W. Branch .	March.	...	...	...	
Ditto	July .	+11·09	+11·81	+11·50	
Ditto	Aug. .	+20·75	+ 1·74	+11·09	
Ditto	Sept. .	+10·97	—11·23	+11·22	Removed to Lake Hill, 19th September.
Lake Hill . .	Sept. .	...	...	...	Stopped several times during these two months without apparent cause. It was taken by Captain Robinson to England, in the winter of 1844, and placed in the maker's hands for examination.
Ditto	Oct. .	...	...	...	
	1845				
St. Helen's Island.	May .	—0·23	—4·99	—2·19	
Ditto	June .	—1·82	+0·72	—0·15	
Lake Memphramagog.	Aug. .	—2·91	—1·93	—2·42	
Ditto . . .	Sept. .	+0·52	—0·85	—0·09	

POCKET CHRONOMETER No. 2187, ARNOLD.

Station.	Date.	Rates. Range during month. From	Rates. Range during month. To	Average or mean of Rates determined during the month.	Remarks.
	1843	s.	s.	s.	
Royal Observatory, Greenwich.	April .	...	...	— 2·4	
On passage out .	April .	...	...	— 2·1	On board steamer "Hibernia."
New Brunswick, Grand Falls.	July .	— 0·43	— 1·91	— 1·34	Travelling constantly to and fro for determining difference of longitude.
Mouth of St. Francis.	Aug. .	— 1·88	— 0·71	— 1·20	
Ditto	Sept. .	— 0·92	— 4·50	— 2·34	
Ditto	Oct. .	— 3·80	— 0·43	— 2·42	
Forks of St. John	Nov. .	+28·96	— 3·94	+ 8·27	Kept in a log-hut warmed with stove. Temperature varying frequently from 60° in the day down to some unknown quantity below—19° Fahr. at night.
Ditto	Dec. .	— 4·07	— 5·90	— 4·70	
	1844				
Ditto	Jan. .	— 1·87	+ 0·52	— 0·85	
					February, no observations for time.
N. W. Branch .	March.	— 0·86	— 7·21	— 2·77	April, May, and June, 1844, no observations for time; engaged running and cutting out the 64-mile line, &c.
Ditto	July .	+ 3·54	+ 5·30	+ 4·29	
Ditto	Aug. .	+ 3·50	+ 7·08	+ 5·16	
Ditto	Sept. .	+ 5·63	+ 6·55	+ 6·15	Removed to Lake Hill, 19th September.
Lake Hill . .	Sept. .	+10·88	+13·57	+12·49	Operations in the field closed for the season in October, 1844.
	1845				
St. Helen's Island, Montreal.	May .	+10·06	— 0·43	+ 4·65	Recommenced May, 1845.
Ditto	June .	— 0·99	+ 3·54	+ 1·13	
Lake Memphramagog.	Aug. .	— 0·33	+ 4·29	+ 1·82	
Ditto	Sept .	— 1·15	+ 4·80	+ 2·69	Operations in the field, and observations terminated, Sept. 1845.

(Signed) WM. ROBINSON,
Captain Royal Engineers.

Observations for Difference of Longitude between the Astronomical Station at Rouse's Point, under charge of Major J. D. Graham, United States' Topographical Engineers, and the Astronomical Station on the east shore of Lake Memphramagog, in Standstead, Canada East, under charge of Captain Robinson, Royal Engineers, made upon flashes of gunpowder fired from the top of Jay Peak, in the south-west part of the Township of Jay in the State of Vermont, August, 1845.

Signals made on August 1, between 9 h. and 11 h., at 10 Minutes' Intervals.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
Lake Memphramagog	2277	18 13 25·0	Fast 10 12·18	18 3 12·82	4 34·82
Rouse's Point . . .	2557	18 2 21·15	„ 3 43·5	17 58 38·00	
Lake Memphramagog	2277	18 23 36·5	„ 10 12·18	18 13 24·32	4 35·32
Rouse's Point . . .	2557	18 12 32·5	„ 3 43·5	18 8 49·00	
Lake Memphramagog	2277	18 43 28·0	„ 10 12·18	18 33 15·82	4 35·32
Rouse's Point . . .	2557	18 32 24·0	„ 3 43·5	18 28 40·50	
Lake Memphramagog	2277	19 3 32·0	„ 10 12·18	18 53 19·82	4 35·62
Rouse's Point . . .	2557	18 52 27·7	„ 3 43·5	18 48 44·20	
Lake Memphramagog	2277	19 13 32·5	„ 10 12·18	19 3 20·32	4 35·82
Rouse's Point . . .	2557	19 2 28·0	„ 3 43·5	18 58 44·50	
Lake Memphramagog	2277	19 24 9·0	„ 10 12·18	19 13 56·82	4 36·02
Rouse's Point . . .	2557	19 13 4·3	„ 3 43·5	19 9 20·80	
Lake Memphramagog	2277	19 33 37·0	„ 10 12·18	19 23 24·82	4 35·92
Rouse's Point . . .	2557	19 22 32·4	„ 3 43·5	19 18 48·90	
Lake Memphramagog	2277	19 43 34·0	„ 10 12·18	19 33 21·82	4 35·32
Rouse's Point . . .	2557	19 32 30·0	„ 3 43·5	19 28 46·5	
Lake Memphramagog	2277	19 53 41·5	„ 10 12·18	19 43 29·32	4 35·82
Rouse's Point . . .	2557	19 42 37·0	„ 3 43·5	19 38 53·50	
				9)	49·98

Mean difference of longitude obtained on August 1 = 4 35·55

Signals made on August 3, between $8\frac{1}{2}$ h. and $9\frac{1}{2}$ h., at 3 Minutes' Intervals.

Lake Memphramagog	2277	17 40 8·0	Fast 10 14.80	17 29 53.20	4 34·62
Rouse's Point . . .	2557	17 29 2·7	„ 3 44·12	17 25 18·58	
Lake Memphramagog	2277	17 43 15·5	„ 10 14·80	17 33 0·70	4 34·62
Rouse's Point . . .	2557	17 32 10·2	„ 3 44·12	17 28 26·08	
Lake Memphramagog	2277	17 46 7·0	„ 10 14·80	17 35 52·20	4 34·32
Rouse's Point . . .	2557	17 35 2·0	„ 3 44·12	17 31 17·88	
Lake Memphramagog	2277	17 49 9·0	„ 10 14·80	17 38 54·20	4 34·22
Rouse's Point . . .	2557	17 38 4·1	„ 3 44·12	17 34 19·98	
Lake Memphramagog	2277	17 52 9·0	„ 10 14·80	17 41 54·20	4 34·32
Rouse's Point . . .	2557	17 41 4·0	„ 3 44·12	17 37 19·88	

Carried forward . 22·10

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
			M. S.	H. M. S.	M. S.
				Bro^t. forward	22·10
Lake Memphramagog	2277	17 55 9·5	Fast 10 14·80	17 44 54·7	4 34·62
Rouse's Point . . .	2557	17 44 4·2	„ 3 44·12	17 40 20·08	
Lake Memphramagog	2277	17 58 8·0	„ 10 14·80	17 47 53·20	4 34·32
Rouse's Point . . .	2557	17 47 3·0	„ 3 44·12	17 43 18·88	
Lake Memphramagog	2277	18 1 7·0	„ 10 14·80	17 50 52·20	4 34·32
Rouse's Point . . .	2557	17 50 2·0	„ 3 44·12	17 46 17·88	
Lake Memphramagog	2277	18 4 6·0	„ 10 14·80	17 53 51·20	4 34·62
Rouse's Point . . .	2557	17 53 0·7	„ 3 44·12	17 49 16·58	
Lake Memphramagog	2277	18 7 10·0	„ 10 14·80	17 56 55·20	4 34·62
Rouse's Point . . .	2557	17 50 4·7	„ 3 44·12	17 52 20·58	
Lake Memphramagog	2277	18 10 11·5	„ 10 14·80	17 59 56·70	4 34·82
Rouse's Point . . .	2557	17 59 6·0	„ 3 44·12	17 55 21·88	
Lake Memphramagog	2277	18 13 11·5	„ 10 14·80	18 2 56·70	4 34·42
Rouse's Point . . .	2557	18 2 6·4	„ 3 44·12	17 58 22·28	
Lake Memphramagog	2277	18 16 13·5	„ 10 14·80	18 5 58·70	4 34·42
Rouse's Point . . .	2557	18 5 8·4	„ 3 44·12	18 1 24·28	
Lake Memphramagog	2277	18 19 17·0	„ 10 14·80	18 9 2·20	4 34·62
Rouse's Point . . .	2557	18 8 11·7	„ 3 44·12	18 4 27·58	
Lake Memphramagog	2277	18 22 19·5	„ 10 14·80	18 12 4·70	4 34·62
Rouse's Point . . .	2557	18 11 14·2	„ 3 44.12	18 7 30·08	
				15)	67·50

Mean difference of longitude obtained on August 3=4 34·50

SIGNALS made on AUGUST 5, from $8\frac{1}{2}$ h. to $9\frac{1}{2}$ h.

Lake Memphramagog	2277	17 59 58·0	Fast 10 11·99	17 49 46·01	4 35·05
Rouse's Point . . .	2557	17 48 56·5	„ 3 45·54	17 45 10·96	
Lake Memphramagog	2277	18 2 55 0	„ 10 11·99	17 52 43·01	4 34·05
Rouse's Point . . .	2557	17 51 54·5	„ 3 45·54	17 48 8·96	
Lake Memphramagog	2277	18 5 52·0	„ 10 11·99	17 55 40·01	4 34·15
Rouse's Point . . .	2557	17 54 51·4	„ 3 45·54	17 51 5·86	
Lake Memphramagog	2277	18 8 54·0	„ 10 11·99	17 58 42·01	4 34·65
Rouse's Point . . .	2557	17 57 52·9	„ 3 45·54	17 54 7·36	
Lake Memphramagog	2277	18 11 53·5	„ 10 11·99	18 1 41·51	4 35·05
Rouse's Point . . .	2557	18 0 52·0	„ 3 45·54	17 57 6·46	
Lake Memphramagog	2277	18 14 55·0	„ 10 11·99	18 4 43·01	4 35·05
Rouse's Point . . .	2557	18 3 53·5	„ 3 45·54	18 0 7·96	
Lake Memphramagog	2277	18 17 56·5	„ 10 11·99	18 7 44·51	4 34·35
Rouse's Point . . .	2557	18 6 55·7	„ 3 45·54	18 3 10·16	
Lake Memphramagog	2277	18 21 0·5	„ 10 11·99	18 10 48·51	4 34·55
Rouse's Point . . .	2557	18 9 59·5	„ 3 45·54	18 6 13·96	
Lake Memphramagog	2277	18 23 58·5	„ 10 11.99	18 13 46·51	4 34·55
Rouse's Point . . .	2557	18 12 57·5	„ 3 45·54	18 9 11·96	
Lake Memphramagog	2277	18 27 1·5	„ 10 11·99	18 16 49·51	4 34·45
Rouse's Point . . .	2557	18 16 0·6	„ 3 45·54	18 12 15·06	
Lake Memphramagog	2277	18 30 8·0	„ 10 11·99	18 19 56 01	4 34·55
Rouse's Point . . .	2557	18 19 7·0	„ 3 45·54	18 15 21·46	
				11)	50·45

Mean difference of longitude obtained on August 5=4 34·59

SIGNALS made AUGUST 2 .845, from 8 h. to 9 h., at 2 MINUTES' INTERVALS.

Name and Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
			M. S.	H. M. S.	M. S.
Lake Memphramagog	2277	18 25 12·0	Fast 10 21·12	18 14 50·88	4 34·31
Rouse's Point . . .	2557	18 14 16·0	„ 3 59·93	18 10 16·07	
Lake Memphramagog	2277	18 36 10·0	„ 10 21·12	18 25 48·88	4 35·01
Rouse's Point . . .	2557	18 25 13·8	„ 3 59·93	18 21 13·87	
Lake Memphramagog	2277	18 40 32·5	„ 10 21·12	18 30 11·88	4 35·31
Rouse's Point . . .	2557	18 29 36·0	„ 3 59·93	18 25 36·07	
Lake Memphramagog	2277	18 47 2·5	„ 10 21·12	18 36 41·38	4 35·21
Rouse's Point . . .	25[illegible]	18 36 6·1	„ 3 59·93	18 32 6·17	
Lake Memphramagog	2277	18 49 13·0	„ 10 21·12	18 38 51·88	4 34·81
Rouse's Point . . .	2557	18 38 17·0	„ 3 59·93	18 34 17·07	
Lake Memphramagog	2277	18 51 23·5	„ 10 21·12	18 41 2·38	4 34·61
Rouse's Point . . .	2557	18 40 27·7	„ 3 59·93	18 36 27·77	
Lake Memphramagog	2277	18 53 34·0	„ 10 21·12	18 43 1[illegible]·[illegible]8	4 35·31
Rouse's Point . . .	2557	18 42 37·5	„ 3 59·93	18 38 37·57	
Lake Memphramagog	2277	18 55 44·5	„ 10 21·12	18 45 23·38	4 34·71
Rouse's Point . . .	2557	18 44 48·6	„ 3 59·93	18 40 48·67	
Lake Memphramagog	2277	18 57 55·0	„ 10 21·12	18 47 33·88	4 34·61
Rouse's Point . . .	2557	18 46 59·2	„ 3 59·93	18 42 59·27	
Lake Memphramagog	2277	19 0 5·5	„ 10 21·12	18 49 44·38	4 34·81
Rouse's Point . . .	2557	18 49 9·5	„ 3 59·93	18 45 9·57	
Lake Memphramagog	2277	19 2 15·0	„ 10 21·12	18 51 53·88	4 34·71
Rouse's Point . . .	2557	18 51 19·1	„ 3 59·23	18 47 19·17	
Lake Memphramagog	2277	19 4 27·0	„ 10 21·12	18 54 5·88	4 35·31
Rouse's Point . . .	2557	18 53 30·5	„ 3 59·93	18 49 30·57	
Lake Memphramagog	2277	19 6 38·5	„ 10 21·12	18 56 17·38	4 34·71
Rouse's Point . . .	2557	18 55 42·6	„ 3 59·93	18 51 42·67	
Lake Memphramagog	2277	19 8 48·0	„ 10 21·12	18 58 26·88	4 35·31
Rouse's Point . . .	2557	18 57 51·5	„ 3 59·93	18 53 51·57	
				14)	69·24

Mean difference of longitude obtained on August 24 = 4 34·95

SIGNALS made on AUGUST 26, 1845, from 8 h. to 9 h.

Name and Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
Lake Memphramagog	2277	18 38 44·0	Fast 10 20·91	18 28 23·09	4 35·33
Rouse's Point . . .	2557	18 27 49·8	„ 4 2·04	18 23 47·76	
Lake Memphramagog	2277	18 40 52·8	„ 10 20·91	18 30 31·8[illegible]	4 35·13
Rouse's Point . . .	2557	18 29 58·8	„ 4 2·04	18 25 56·76	
Lake Memphramagog	2277	18 43 4·0	„ 10 20·91	18 32 43·09	4 35·47
Rouse's Point . . .	2557	18 32 11·4	„ 4 2·04	18 28 7·62	
Lake Memphramagog	2277	18 47 26·2	„ 10 20·91	18 37 5·29	4 35·33
Rouse's Point . . .	2557	18 36 32·0	„ 4 2·04	18 32 29·96	
Lake Memphramagog	2277	18 49 38·7	„ 10 20·91	18 39 17·79	4 35·53
Rouse's Point . . .	2557	18 38 44·3	„ 4 2·04	18 34 42·26	

Carried forward . 26·79

Name and Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	26·79
Lake Memphramagog	2277	18 51 49·2	Fast 10 20·91	18 41 28·29	4 35·33
Rouse's Point . . .	2557	18 40 55·0	„ 4 2·04	18 36 52·96	
Lake Memphramagog	2277	18 53 58·5	„ 10 20·91	18 43 37·59	4 35·23
Rouse's Point . . .	2557	18 43 4·4	„ 4 2·04	18 39 2·36	
Lake Memphramagog	2277	18 56 7·6	„ 10 20·91	18 45 46·69	4 35·43
Rouse's Point . . .	2557	18 54 13·3	„ 4 2·04	18 41 11·26	
Lake Memphramagog	2277	19 0 28.8	„ 10 20·91	18 50 7·89	4 35·43
Rouse's Point . . .	2557	18 49 34·5	„ 4 2·04	18 45 32·46	
Lake Memphramagog	2277	19 2 38·6	„ 10 20·91	18 52 17·69	4 35·43
Rouse's Point . . .	2557	18 51 44·3	„ 4 2·04	18 47 42·26	
Lake Memphramagog	2277	19 4 49·7	„ 10 20·91	18 54 28·79	4 35·43
Rouse's Point . . .	2557	18 53 55·4	„ 4 2·04	18 49 53·36	
Lake Memphramagog	2277	19 6 59·2	„ 10 20·91	18 56 38·29	4 35·43
Rouse's Point . . .	2557	18 56 4·9	„ 4 2·04	18 52 2·86	
Lake Memphramagog	2277	19 9 9·0	„ 10 20·91	18 58 48·09	4 35·43
Rouse's Point . . .	2557	18 58 14·6	„ 4 2·04	18 54 12·56	
Lake Memphramagog	2277	19 11 19·2	„ 10 20·91	19 0 58·29	4 35·53
Rouse's Point . . .	2557	19 0 24·8	„ 4 2·04	18 56 22·76	
Lake Memphramagog	2277	19 13 28·7	„ 10 20·91	19 3 7·79	4 35·53
Rouse's Point . . .	2557	19 2 34·3	„ 4 2·04	18 58 32·26	
				15)	81·09

Mean difference of longitude obtained on August 26 = 4 35·41

SIGNALS made on AUGUST 28, 1845, from 8 h. to 9 h.

Name and Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
Lake Memphramagog	2277	18 45 6·2	Fast 10 21·09	18 34 45·11	4 35·62
Rouse's Point . . .	2557	18 34 13·0	„ 4 3·51	18 30 9·42	
Lake Memphramagog	2277	18 47 16·4	„ 10 21·09	18 36 55·31	4 35·42
Rouse's Point . . .	2557	18 36 23·4	„ 4 3·51	18 32 19·89	
Lake Memphramagog	2277	18 49 26·8	„ 10 21·09	18 39 5·71	4 35·72
Rouse's Point . . .	2557	18 38 33·5	„ 4 3·51	19 34 29·99	
Lake Memphramagog	2277	18 51 39·2	„ 10 21·09	18 41 8·11	4 35·62
Rouse's Point . . .	2557	18 40 46·0	„ 4 3·51	18 36 42·49	
Lake Memphramagog	2277	18 56 1·6	„ 10 21·09	18 45 40·51	4 35·42
Rouse's Point . . .	2557	18 45 8·6	„ 4 3·51	18 41 5·09	
Lake Memphramagog	2277	18 58 13·0	„ 10 21·09	18 47 51·91	4 35·72
Rouse's Point . . .	2557	18 47 19·7	„ 4 3·51	18 43 16·19	
Lake Memphramagog	2277	19 0 24·8	„ 10 21·09	18 50 3·71	4 35·22
Rouse's Point . . .	2557	18 49 32·0	„ 4 3·51	18 45 28·49	
Lake Memphramagog	2277	19 7 0·0	„ 10 21·09	18 56 38·91	4 35·42
Rouse's Point . . .	2557	18 56 7·0	„ 4 3·51	18 52 3·49	
Lake Memphramagog	2277	19 9 12·7	„ 10 21·09	18 58 51·61	4 35·62
Rouse's Point . . .	2557	18 58 19·5	„ 4 3·51	18 54 15·99	
Lake Memphramagog	2277	19 11 24·2	„ 10 21·09	19 1 3·11	4 35·32
Rouse's Point . . .	2557	19 0 31·3	„ 4 3·51	18 56 27·79	

Carried forward . 55·10

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	55·10
Lake Memphramagog	2277	19 13 36·0	Fast 10 21·09	19 3 14·91	4 35·62
Rouse's Point . . .	2557	19 2 42·8	„ 4 3·51	18 58 39·29	
Lake Memphramagog	2277	19 15 48·0	„ 10 21·09	19 5 27·51	4 35·52
Rouse's Point . . .	2557	19 4 55·5	„ 4 3·51	19 0 51·99	
Lake Memphramagog	2277	19 18 0·5	„ 10 21·09	19 7 39·41	4 35·52
Rouse's Point . . .	2557	19 7 7·4	„ 4 3·51	19 3 3·89	
Lake Memphramagog	2277	19 20 12·4	„ 10 21·09	19 9 51·31	4 35·32
Rouse's Point . . .	2557	19 9 19·5	„ 4 3·51	19 5 15·99	
Lake Memphramagog	2277	19 21 23·2	„ 10 21·09	19 12 2·11	4 35·32
Rouse's Point . . .	2557	19 11 30·3	„ 4 3·51	19 7 26·79	
Lake Memphramagog	2277	19 24 35·0	„ 10 21·09	19 14 13·91	4 35·42
Rouse's Point . . .	2557	19 13 42·0	„ 4 3·51	19 9 38·49	
				16)	87·82

Mean difference of longitude obtained on August 28 = 4 35·49

ABSTRACT OF FOREGOING.

			M.	S.
August 1,	difference of longitude by means of	9 flashes . .	4	35·55
„ 3,	„ „	15 „ . .	4	34·50
„ 5,	„ „	11 „ . .	4	34·59
„ 24,	„ „	14 „ . .	4	34·95
„ 26,	„ „	15 „ . .	4	35·41
„ 28,	„ „	16 „ . .	4	35·49
			6)	30·49

Difference of longitude by a mean of 6 nights' observations = 4 35·08

(Signed) WM. ROBINSON,

Captain Royal Engineers.

TIMES of Observations of the Signals made at Jay Mountain for determining the Difference of Longitude between Captain Robinson's Astronomical Station at Lake Memphramagog and that of Lieutenant Thom, United States' Topographical Engineers, at Richford.

SIGNALS made on AUGUST 24, 1845, by FLASHES of GUNPOWDER fired at about 2 MINUTES' INTERVALS, from 8 h. to 9 h., APPROXIMATE SOLAR TIME.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
Lake Memphramagog	2277	18 25 12·0	Fast 10 21·12	18 14 50·88	
Richford*	2419	18 12 57·2	......	18 12 57·27	1 53·61
	1582	·34			
Lake Memphramagog	2277	18 27 25·0	„ 10 21·12	18 17 3·88	
Richford	2419	......	......	18 15 10·20	1 53·68
	1582	18 15 10·02			
Lake Memphramagog	2277	18 34 0·8	„ 10 21·12	18 23 38·88	
Richford	2419	18 21 45·10	......	18 21 44·90	1 53·98
	1582	44·69			
Lake Memphramagog	2277	18 36 10·0	„ 10 21·12	18 25 48·88	
Richford	2419	18 23 55·20	......	18 23 15·29	1 53·59
	1582	·39			
Lake Memphramagog	2277	18 38 20·5	„ 10 21·12	18 27 59·38	
Richford	2419	18 26 6·30	......	18 26 6·44	1 52·94
	1582	·59			
Lake Memphramagog	2277	18 40 32·5	„ 10 21·12	18 30 11·38	
Richford	2419	18 28 17·40	......	18 28 17·62	1 53·76
	1582	·85			
Lake Memphramagog	2277	18 42 42·0	„ 10 21·12	18 32 20·88	
Richford	2419	18 30 27·20	......	18 30 27·25	1 53·63
	1582	·30			
Lake Memphramagog	2277	18 44 52·5	„ 10 21·12	18 34 31·38	
Richford	2419	18 32 37·80	......	18 32 37·70	1 53·68
	1582	·60			
Lake Memphramagog	2277	18 47 2·5	„ 10 21·12	18 36 41·38	
Richford	2419	18 34 47·60	......	18 34 47·75	1 53·63
	1582	·91			
Lake Memphramagog	2277	18 49 13·0	„ 10 21·12	18 38 51·88	
Richford	2419	18 36 58·50	......	18 36 58·43	1 53·45
	1582	·37			
Lake Memphramagog	2277	18 51 23·5	„ 10 21·12	18 41 2·38	
Richford	2419	18 39 9·10	......	18 39 9·06	1 53·32
	1582	·03			
Lake Memphramagog	2277	18 53 34·0	„ 10 21·12	18 43 12·88	
Richford	2419	18 41 14·96	......	18 41 19·29	1 53·59
	1582	·19			
				Carried forward .	42·86

* At Richford, the flashes were observed on two chronometers. The mean of the two is used.—W. R.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Bro^t. forward	42·86
Lake Memphramagog	2277	18 55 44·5	Fast 10 21·12	18 45 23·38	
Richford	2419	18 43 30·20	......	18 43 30·17	1 53·21
	1582	·14			
Lake Memphramagog	2277	18 57 55·0	„ 10 21·12	18 47 33·88	
Richford	2419	18 45 40·90	......	18 45 40·85	1 53·03
	1582	·80			
Lake Memphramagog	2277	19 0 5·5	„ 10 21·12	18 49 44·38	
Richford	2419	18 47 50·90	......	18 47 50·97	1 53·41
	1582	51·05			
Lake Memphramagog	2277	19 2 15·0	„ 10 21·12	18 51 53·88	
Richford	2419	18 50 1·00	......	18 50 1·10	1 52·78
	1582	·21			
Lake Memphramagog	2277	19 4 27·0	„ 10 21·12	18 54 5·88	
Richford	2419	18 52 11·80	......	18 52 11·88	1 54·00
	1582	·90			
Lake Memphramagog	2277	19 6 38·5	„ 10 21·12	18 56 17·38	
Richford	2419	18 54 23·90	......	18 54 23·91	1 53·47
	1582	·92			
Lake Memphramagog	2277	19 8 48·0	„ 10 21·12	18 58 26·88	
Richford	2419	18 56 33·10	......	18 56 33·19	1 53·69
	1582	·29			
				19)	66·45

Mean difference of longitude on August 24, by 19 observations = 1 53·50

Signals made on August 26, 1845, from 8 h. to 9 h., p.m., Approximate Solar Time.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
Lake Memphramagog	2277	18 38 44·0	Fast 10 20·91	18 28 23·09	
Richford	2419	18 26 29·27	......	18 26 29·19	1 53·90
	1582	·12			
Lake Memphramagog	2277	18 40 52·8	„ 10 20·91	18 30 31·89	
Richford	2419	18 28 38·47	......	18 28 38·37	1 53·52
	1582	·27			
Lake Memphramagog	2277	18 43 4·0	„ 10 20·91	18 32 43·09	
Richford	2419	18 30 49·27	......	18 30 49·49	1 53·60
	1582	·71			
Lake Memphramagog	2277	18 45 14·8	„ 10 20·91	18 34 53·89	
Richford	2419	18 33 0·20	......	18 33 0·24	1 53·65
	1582	·29			
Lake Memphramagog	2277	18 47 26·2	„ 10 20·91	18 37 5·29	
Richford	2419	18 35 11·67	......	18 35 11·36	1 53·93
	1582	·05			
Lake Memphramagog	2277	18 49 38·7	„ 10 20·91	18 39 17·79	
Richford	2419	18 37 23·77	......	18 37 23·74	1 54·05
	1582	·71			
Lake Memphramagog	2277	18 51 49·2	„ 10 20·91	18 41 28·29	
Richford	2419	18 39 34·67	......	18 39 34·51	1 53·78
	1582	·36			

Carried forward . 26·43

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Bro^t. forward	26·43
Lake Memphramagog	2277	18 53 58·5	Fast 10 20·91	18 43 37·59	
Richford	2419	18 41 43·77	......	18 41 43·59	1 54·00
	1582	·42			
Lake Memphramagog	2277	18 58 18·5	„ 10 20·91	18 47 57·59	
Richford	2419	18 46 3·67	....	18 46 3·80	1 53·79
	1582	·93			
Lake Memphramagog	2277	19 0 28·8	„ 10 20·91	18 50 7·89	
Richford	2419	19 48 13·17	......	18 48 13·27	1 54·62
	1582	·38			
Lake Memphramagog	2277	19 2 38·6	„ 10 20·91	18 52 17·69	
Richford	2419	18 50 24·07	......	18 50 24·00	1 53·69
	1582	23 94			
Lake Memphramagog	2277	19 4 49·7	„ 10 20·91	18 54 28·79	
Richford	2419	18 52 34·87	......	18 52 35·03	1 53·66
	1582	35·19			
Lake Memphramagog	2277	19 6 59·2	„ 10 20·91	18 56 38·29	
Richford	2419	18 54 44·57	......	18 54 44·57	1 53·72
	1582				
Lake Memphramagog	2277	19 9 9·0	„ 10 20·91	18 58 48·09	
Richford	2419	18 56 44·47	......	18 56 54·47	1 53·62
	1582				
Lake Memphramagog	2277	19 11 19·2	„ 10 20·91	19 0 58·29	
Richford	2419	18 59 4·57	......	18 59 4·46	1 53·83
	1582	·36			
Lake Memphramagog	2277	19 13 28·57	„ 10 20·91	19 3 7·79	
Richford	2419	19 1 13·87	......	19 1 13·84	1 53·95
	1582	·81			
				16)	61·31

Mean difference of longitude on August 26, by 16 observations = 1 53·83

Signals made on August 28, 1845, from 8 h. to 9 h., Approximate Solar Time.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
Lake Memphramagog	2277	18 45 6·2	Fast 10 21·09	18 34 45·11	
Richford	2419	18 32 51·36	......	18 32 51·51	1 53·60
	1582	·67			
Lake Memphramagog	2277	18 47 16·4	„ 10 21·09	18 36 55·31	
Richford	2419	18 35 1·46	......	18 35 1·74	1 53·57
	1582	2·03			
Lake Memphramagog	2277	18 49 26·8	„ 10 21·09	18 39 5·71	
Richford	2419	18 37 11·76	......	18 37 12·03	1 53·68
	1582	12·29			
Lake Memphramagog	2277	18 51 39·2	„ 10 21·09	18 41 18·11	
Richford	2419	18 39 24·36	......	18 39 24·61	1 53·50
	1582	·89			
Lake Memphramagog	2277	18 56 1·6	„ 10 21·09	18 45 40·51	
Richford	2419	18 43 46·86	.....	18 43 47·01	1 53·50
	1582	47·16			

Carried forward . 17·85

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	17·85
Lake Memphramagog	2277	18 58 13·0	Fast 10 21·09	18 47 51·91	
Richford	2419	18 45 57·86	......	18 45 58·24	1 53·67
	1582	58·62			
Lake Memphramagog	2277	19 0 24·8	,, 10 21·09	18 50 3·71	
Richford	2419	13 48 9·76	......	18 48 9·97	1 53·74
	1582	10·18			
Lake Memphramagog	2277	19 7 0·0	,, 10 21·09	18 56 38·91	
Richford	2419	18 54 45·26	......	18 54 45·26	1 53·65
	1582				
Lake Memphramagog	2277	19 9 12·7	,, 10 21·09	18 58 51·61	
Richford	2419	18 56 57·66	......	18 56 58·04	1 53·57
	1582	58·42			
Lake Memphramagog	2277	19 11 24·2	,, 10 21·09	19 1 3·11	
Richford	2419	18 59 9·56	......	18 59 9·77	1 53·34
	1582	·98			
Lake Memphramagog	2277	19 13 36·0	,, 10 21·09	19 3 14·91	
Richford	2419	19 1 21·15	......	19 1 21·34	1 53·57
	1582	·54			
Lake Memphramagog	2277	19 15 48·6	,, 10 21·09	19 5 27·51	
Richford	2419	19 3 33·86	......	19 3 33·86	1 53·65
	1582				
Lake Memphramagog	2277	19 18 0·5	,, 10 21·09	19 7 39·41	
Richford	2419	19 5 45·76	......	19 5 45·81	1 53·60
	1582	·86			
Lake Memphramagog	2277	10 22 23·2	,, 10 21·09	19 12 2·11	
Richford	2419	19 10 8·26	......	19 10 8·26	1 53·85
	1582				
Lake Memphramagog	2277	19 24 35·0	,, 10 21·09	19 14 13·91	
Richford	2419	19 12 20·26	.....	19 12 20·60	1 53·31
	1582	·94			
				15)	53·80

Mean difference of longitude on August 28, by 15 observations = 1 53·58

SIGNALS made on AUGUST 29, 1845, between 8 h. and 9 h., APPROXIMATE SOLAR TIME.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
Lake Memphramagog	2277	19 9 56·8	Fast 10 21·10	18 59 35·70	
Richford	2419	18 57 41·70	......	18 57 41·64	1 54·06
	1582	·59			
Lake Memphramagog	2277	19 14 20·2	,, 10 21·10	19 3 59·1	
Richford	2419	19 2 4·70	......	19 2 4·90	1 54·20
	1582	5·11			
Lake Memphramagog	2277	19 16 31·30	,, 10 21·10	19 6 10·20	
Richford	2419	19 4 16·20	......	19 4 16·28	1 53·92
	1582	·37			
Lake Memphramagog	2277	19 20 54·4	,, 10 21·10	19 10 33·3	
Richford	2419	19 8 39·10	......	19 8 39·14	1 54·16
	1582	·19			

Carried forward . 16·34

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	16·34
Lake Memphramagog	2277	19 23 5·8	Fast 10 21·10	19 12 44·7	
Richford	2419	19 10 50·60	......	19 10 50·52	1 54·18
	1582	·45			
Lake Memphramagog	2277	19 25 17·6	„ 10 21·10	19 14 56·5	
Richford	2419	19 13 2·40	......	19 13 2·70	1 53·80
	1582	3·01			
Lake Memphramagog	2277	19 27 29·5	„ 10 21·10	19 17 8·4	
Richford	2419	19 15 14·10	......	19 15 14·13	1 54·27
	1582	·17			
Lake Memphramagog	2277	19 29 40·4	„ 10 21·10	19 19 19·3	
Richford	2419	19 17 24·90	......	19 17 24·97	1 54·33
	1582	25·03			
					8) 32·92

Mean difference of longitude on August 29, by 8 observations = 1 54·11

SIGNALS made on SEPTEMBER 8, 1845, from 8 h. to 9 h., APPROXIMATE SOLAR TIME.

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
Lake Memphramagog	2277	19 29 33 6	Fast 10 14·84	19 19 18·76	
Richford	2419	19 17 24·86	......	19 17 24·84	1 53·92
	1582	·83			
Lake Memphramagog	2277	19 31 45·8	„ 10 14·84	19 21 30·96	
Richford	2419	19 19 37·15	......	19 19 37·17	1 53·79
	1582	·19			
Lake Memphramagog	2277	19 33 56·8	„ 10 14·84	19 23 41·96	
Richford	2419	19 21 48·15	......	19 21 48·15	1 53·81
	1582	·15			
Lake Memphramagog	2277	19 36 10·5	„ 10 14·84	19 25 55·66	
Richford	2419	29 24 0·95	......	19 24 0·88	1 54·78
	1582	·81			
Lake Memphramagog	2277	19 38 22·0	„ 10 14·84	19 28 7·16	
Richford	2419	19 26 13·15	......	19 26 13·21	1 53·95
	1582	·27			
Lake Memphramagog	2277	19 40 33·5	„ 10 14·84	19 30 18·66	
Richford	2419	19 28 24·75	......	18 28 24·73	1 53·93
	1582	·71			
Lake Memphramagog	2277	19 42 45·2	„ 10 14·84	19 32 30·36	
Richford	2419	19 30 36·55	......	19 30 36·62	1 53·74
	1582	·69			
Lake Memphramagog	2277	19 44 56·4	„ 10 14·84	19 34 41·16	
Richford	2419	19 32 47·55	......	19 32 47·45	1 54·11
	1582	·35			
Lake Memphramagog	2277	19 47 9·0	„ 10 14·84	19 36 54·16	
Richford	2419	19 35 0·55	......	19 35 0·43	1 53·73
	1582	·31			
Lake Memphramagog	2277	19 49 20·2	„ 10 14·84	19 39 5·36	
Richford	2419	19 37 11·25	......	19 37 11·45	1 53·91
	1582	·66			
				Carried forward .	39·67

Name of Station.	Chrono-meters' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longi-tude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	39·67
Lake Memphramagog	2277	19 51 32·5	Fast 10 14·84	19 41 17·66	
Richford	2419	19 39 23·85	......	19 39 23·84	1 53·82
	1582	·83			
Lake Memphramagog	2277	19 53 44·2	„ 10 14·84	19 43 29·36	
Richford	2419	19 41 35·25	......	19 41 35·27	1 54·09
	1582	·29			
Lake Memphramagog	2247	19 55 56·7	„ 10 14·84	19 45 41·86	
Richford	2419	19 43 47·95	......	19 43 47·85	1 54·01
	1582	·75			
Lake Memphramagog	2277	19 58 8·5	„ 10 14·84	19 47 53·66	
Richford	2419	19 45 59·75	......	19 45 59·48	1 54·18
	1582	·21			
Lake Memphramagog	2277	20 0 20·8	„ 10 14·84	19 50 5·96	
Richford	2419	19 48 11·75	......	19 48 11·66	1 54·30
	1582	·57			
Lake Memphramagog	2277	20 2 31·0	„ 10 14·84	19 52 16·16	
Richford	2419	19 50 22·35	......	19 50 22·54	1 53·62
	1582	·73			
Lake Memphramagog	2277	20 4 44 2	„ 10 14·84	19 54 29·36	
Richford	2419	19 52 35·05	......	19 52 35·17	1 54·19
	1582	·29			
Lake Memphramagog	2277	20 6 56·0	„ 10 14·84	19 56 41·16	
Richford	2419	19 54 47·05	......	19 54 47·00	1 54·16
	1582	46·95			
Lake Memphramagog	2277	20 9 8·8	„ 10 14·84	19 58 53·96	
Richford	2419	19 57 0·02	......	19 57 0 02	1 53·94
	1582				
Lake Memphramagog	2277	20 11 20·8	„ 10 14·84	20 1 5·96	
Richford	2419	19 59 11·75	......	19 59 11·75	1 54·21
	1582				
Lake Memphramagog	2277	20 20 8·8	„ 10 14·84	20 9 53·96	
Richford	2419	20 8 0·05	......	20 7 59·97	1 53·99
	1582	7 59·89			
Lake Memphramagog	2277	20 22 21·0	„ 10 14·84	20 12 6·16	
Richford	2419	20 10 12·35	......	20 10 12·32	1 53·84
	1582	·29			
					22) 88·02

Mean difference of longitude on September 8, by 22 observations = 1 54·00

Signals made on September 16, 1845, from 8 h. to 9 h., Approximate Solar Time.

Lake Memphramagog	2277	20 0 29·7	Fast 9 45·66	19 50 44·04	
Richford	2419	19 48 50·75	......	19 48 50·57	1 53·47
	1582	·40			
Lake Memphramagog	2277	20 4 45·4	„ 9 45·66	19 54 59·74	
Richford	2419	19 53 6·36	......	19 53 6·44	1 53·30
	1582	·52			

Carried forward . 6·77

Name of Station.	Chronometers' Nos.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	True Sidereal Time of Observation.	Difference of Longitude.
		H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	6·77
Lake Memphramagog	2277	20 6 53·3	Fast 9 45·66	19 57 7·64	
Richford	2419	19 55 14·45	......	19 55 14·55	1 53·09
	1582	·65			
Lake Memphramagog	2277	20 9 1·5	„ 9 45·66	19 59 15·84	
Richford	2419	19 57 22·35	......	19 57 22·32	1 53·52
	1582	·30			
Lake Memphramagog	2277	20 11 9·4	„ 9 45·66	20 1 23·74	
Richford	2419	19 59 30·25	......	19 59 30·29	1 53·45
	1582	·34			
Lake Memphramagog	2277	20 13 17·0	„ 9 45·66	20 3 31·34	
Richford	2419	20 1 38·25	......	20 1 38·22	1 53·12
	1582	·20			
Lake Memphramagog	2277	20 15 24·8	„ 9 45·66	20 5 39·14	
Richford	2419	20 3 45·95	......	20 3 46·00	1 53·14
	1582	46·04			
Lake Memphramagog	2277	20 17 32·8	„ 9 45·66	20 7 47·14	
Richford	2419	20 5 53·85	......	20 5 53·92	1 53·22
	1582	54·00			
Lake Memphramagog	2277	20 19 14·2	„ 9 45·66	20 9 55·54	
Richford	2419	20 8 2·05	......	20 8 2·19	1 53·35
	1582	·34			
Lake Memphramagog	2277	20 21 49·5	„ 9 45·66	20 12 3·84	
Richford	2419	20 10 10·55	......	20 10 10·52	1 53·32
	1582	·49			
Lake Memphramagog	2277	20 26 6·8	„ 9 45·66	20 16 21·14	
Richford	2419	20 14 27·75	......	20 14 27·93	1 53·21
	1582	28·10			
Lake Memphramagog	2277	20 32 32·3	„ 9 45·66	20 22 46·64	
Richford	2419	20 20 53·25	......	20 20 53·30	1 53·34
	1582	·35			
Lake Memphramagog	2277	20 34 40·8	„ 9 45·66	20 24 55·14	
Richford	2419	20 23 1·45	......	20 23 1·47	1 53·67
	1582	·50			
Lake Memphramagog	2277	20 36 49·40	„ 9 45·66	20 27 3·74	
Richford	2419	20 25 10·35	......	20 25 10·35	1 53·39
	1582				
Lake Memphramagog	2277	20 38 57·60	„ 9 45·66	20 29 11·94	
Richford	2419	20 27 18·45	......	20 27 18·47	1 53·47
	1582	·50			
					15) 50·06

Mean difference of longitude on September 16, by 15 observations = 1 53·33

ABSTRACT OF FOREGOING.

						M.	S.
August	24,	mean result of	19	corresponding	observations	1	53·50
„	26,	„	16	„	„	1	53·83
„	28,	„	15	„	„	1	53·58
„	29,	„	8	„	„	1	54·11
September	8,	„	22	„	„	1	54·00
„	16,	„	15	„	„	1	53·33
						6)	22·35

Mean of the above 6 sets, comprising 95 observations = 1 53·72

Richford Station, west of Lake Memphramagog Station . . 1 53·72

(Signed) WM. ROBINSON,
Captain, Royal Engineers.

Abstract of differences of Longitude determined by Captain Robinson and Lieutenant Pipon of the Royal Engineers, employed on the North American Boundary, under the Treaty of Washington; in the years 1843, 1844, and 1845.

		M.	S.
1.	Between Grand Falls and Little Falls (or Madawaska) on the River St. John, New Brunswick	2	19·18
2.	Grand Falls and due North Line run by Major Graham from the monument at the source of the St. Croix River. By triangulation . .	0	9·60
3.	Grand Falls and the Boundary Line at its junction with the St. John River. By triangulation	0	11·76
4.	Little Falls (or Madawaska) and the River St. Francis . . .	2	20·43
5.	Mouth of the River St. Francis and the outlet of the Lake Pohenagamook	1	17·47
6.	Mouth of the River St. Francis and the mouth of the Great Black River	2	11·34
7.	Mouth of the Great Black River and the forks of the River St. John .	1	42·14
8.	Forks of the River St. John and the North-West Branch Station. By measurement	0	28·47
9.	North-West Branch Station and the South-West Branch point in 46° 25′ of latitude	0	14·30
10.	North-West Branch Station and Lake Hill. By triangulation . .	0	·69
11.	Lake Hill and Quebec, determined by signals	4	46·32
12.	Astronomical Station, Quebec, and flag-staff, N.E. bastion of citadel. By triangulation	0	3·38
13.	Astronomical Station, Quebec, and Protestant Cathedral, Quebec .	0	2·95
14.	Astronomical Station, Quebec, and Catholic Cathedral, Quebec .	0	2·85
15.	Quebec and St. Helen's Island	9	17·73
16.	St. Helen's Island and Protestant Cathedral, Montreal. By triangulation	0	5·55
17.	St. Helen's Island and Catholic Cathedral, Montreal. By triangulation	0	5·66
18.	St. Helen's Island and St. Regis	4	29·15
19.	St. Helen's Island and Rouse's Point	0	44·09
20.	Rouse's Point and Lake Memphramagog. By signals . . .	4	35·08
21.	Lake Memphramagog and Richford. By signals	1	53·72

(Signed) WM. ROBINSON,
Captain, Royal Engineers.

General Abstract of Latitudes and Longitudes of Stations, determined by Captain Robinson and Lieutenant Pipon, of the Royal Engineers, employed on the North American Boundary, under the Treaty of Washington; in the years 1843, 1844, and 1845.

North Latitude.	Names of Stations.	West Longitude. Time.	West Longitude. Arc.
° ′ ″		H. M. S.	° ′ ″
47 2 50	Astronomical Station at the Grand Falls, New Brunswick	4 30 47·22	67 41 48·3
47 2 55	Costegan's Inn at the Grand Falls, 505 feet north, and 350 east of Astronomical Station	4 30 46·89	67 41 43·3
47 3 36	Due North Line run by Major Graham, from the Monument at the St. Croix River at its junction with the St. John River	4 30 56·82	67 44 12·3
47 3 58	Boundary Line near Grand Falls, at its junction with the River St. John . .	4 30 58·98	67 44 44·7
47 21 50	Astronomical Station at the Little Falls of the River St. John, and near the mouth of the Madawaska River . . . The station was 80 feet north and 70 feet east of the Blockhouse at Madawaska River.	4 33 6·40	68 16 36·0
47 10 57	Astronomical Station near the mouth of River St. Francis . . . . . The Station was 130 feet south and 52 feet west of Hammond's Barn.	4 35 26·83	68 51 42·4
47 27 33	Astronomical Station at outlet of Lake Pohenagamook . . . . . . The large iron monument marking the boundary was placed 66 feet north and 68 feet west nearly of station.	4 36 44·30	69 11 4·5
46 56 55	Astronomical Station at mouth of Great Black River	4 37 38·17	69 24 32·5
46 56 57	Centre of Island at ditto, 200 feet north and 550 feet east of Astronomical Station .	4 37 37·64	69 24 24·6
46 34 38	Astronomical Station 1 mile north of the forks of the River St. John . . . . The Station was about 1 mile north of the actual fork of the river, and 441 feet from the water's edge, at the south-east extremity of the 10-mile (by Treaty) Line.	4 39 20·31	69 50 4·6
46 41 45	Astronomical Station at the north-west branch of the River St. John . . . The Station was 166 feet from the north-west extremity of the 10-mile Treaty Line. The large iron monument at this point, to mark the end of the 64-mile straight line drawn from the outlet of Lake Pohenagamook, was placed close to where the instrument stood.	4 39 48·78	69 57 11·7

North Latitude.	Names of Stations.	West Longitude. Time.	West Longitude. Arc.
° ′ ″		H. M. S.	° ′ ″
46 42 15	Astronomical Station on the top of Lake Hill	4 39 55·68	69 58 55
46 24 53	Astronomical Station on the south-west branch of the River St. John . .	4 40 4·94	70 1 14
46 25 0	Large iron monument marking the 46° 25′ Point by Treaty, on the south-west branch of River St. John	4 40 3·08	70 0 46
46 48 5	Astronomical Station, Plains of Abraham, Quebec	4 44 42·00	71 10 30
46 48 26	Flag-staff, north-east bastion of the Citadel.	4 44 38·62	71 9 39·3
46 48 40	Protestant Cathedral, Quebec . . .	4 44 39·15	71 9 47
46 48 43	Catholic Cathedral, Quebec . . .	4 44 39·05	71 9 45
45 0 28	Astronomical Station, Lake Memphramagog	4 48 40·56	72 10 8
	Station 338 feet north-west of the barn on Blackader's farm.		
45 0 18	Iron monument on the Boundary Line, 1019 feet due south of the Astronomical Station	4 48 40·56	72 10 8
	Richford Station. Station of Lieutenant Thom, United States' Topographical Engineers	4 50 34·28	72 38 34
45 0 28	Astronomical Station, Rouse's Point. Station of Major Graham, United States' Topographical Engineers . . .	4 53 15·64	73 18 54
	Latitude of Fort determined by Major Graham, 45° 0′ 27″.		
45 30 53	Astronomical Station, St. Helen's Island, Montreal	4 53 59·73	73 29
	Station 294 feet south and 445 feet west of the Barony House.		
45 30 26	Protestant Cathedral, Montreal . .	4 54 5·28	73 31 19
45 30 21	Catholic Cathedral, Montreal . . .	4 54 5·39	73 31 21
44 59 59	Boundary Line, 4 Miles from Russeltown.		
	Astronomical Station, 1422 feet west of the monument on the road crossing the Line near John McCoy's house.		
44 59 35	Boundary Line, Trout River.		
	Astronomical Station, 122 feet south and 226 feet east of monument on east bank of river.		
44 59 58½	Astronomical Station, St. Regis . .	4 58 28·88	74 57 13
45 0 1½	Large iron monument at the junction of the Boundary Line with the St. Lawrence River, 280 feet north and 186 feet east of Astronomical Station . . .	4 58 28·71	74 37 10

(Signed) WM. ROBINSON,

Captain, Royal Engineers.

REPORT OF LIEUTENANT PIPON.

For the purpose of tracing portions of the North-Eastern Boundary, and for making a correct map of the whole line, it was necessary to determine the difference of longitude between several points along the frontier.

A brief statement of the modes adopted in getting the difference of longitude is here given, together with a report on the chronometers used for that purpose.

The officers of Royal Engineers, and six non-commissioned officers of the Royal Sappers and Miners, appointed to this duty, were ordered to proceed to America with the necessary instruments and chronometers, by the mail steamer "Hibernia," on the 19th April, 1843.

The chronometers used on the expedition were selected by Professor Airy. They consisted of—

Sidereal Box Chronometers.	Heyes, 51	1 day.
Ditto.	Arnold, 341	ditto.
Ditto.	Parkinson and Frodsham, 2277 .	2 days.
Ditto.	Frodsham, 2	ditto.
Mean time Pocket Chronometers.	Arnold, 2111	1 day.
Ditto.	Arnold, 2187	ditto.
Ditto.	Molyneux, 3091 . . .	ditto.
Ditto.	Molyneux, 3147 . . .	2 days.
Ditto.	Molyneux, 3148 . . .	ditto.
Ditto.	Molyneux, 3226 . . .	1 day.
Ditto.	Molyneux, 3227 . . .	ditto.

Of these, the four box chronometers belonged to the Admiralty; Nos. 2111, 2187, and 3091, belonged to the Foreign Office, and had been in use on former occasions; Nos. 3147 and 3148 were purchased expressly for the expedition; and 3226 and 3227 were lent for the expedition.

For some time previous to setting out, the chronometers were kept at the Royal Observatory, Greenwich, for the purpose of being rated.

They were removed from the Observatory on the 16th April, and carried down to the railway, and, on arrival in London, were conveyed by hackney-coach to the terminus of the Birmingham Railway; from thence they were conveyed on the following morning to Liverpool.

A shelf had been previously fitted up in one of the state-cabins of the "Hibernia" for their reception; and on the morning of the 19th, the day of departure, they were taken on board, and were wound up during the passage out by Captain Robinson. The box chronometers were kept ungymballed whilst on board.

There were two days of very rough weather and heavy sea immediately after leaving Liverpool; the rest of the passage out, with exception of one day off the coast of Newfoundland, was tolerably smooth.

It had been intended that the party should have stopped at Halifax, and gone across by land to the Bay of Fundy, and from thence up the River St. John in New Brunswick, to the scene of operation; but, with a view of avoiding the land-carriage for the chronometers, instructions were left at Halifax by Colonel Estcourt, directing the party to go on to Boston, and proceed from thence by another steamer to St. John's.

The steamer arrived in Boston on the 4th of May; the chronometers were landed with great care. On the 5th, Captain Robinson and Lieutenant Pipon compared the box chronometers with the sidereal clock at Cambridge Observatory; and on the following day the pocket chronometers were sent for comparisons to Mr. Bond, in Congress Street. Having thus obtained the errors of all the chronometers on the sidereal and mean time of Old Cambridge Observatory, and the longitude of Old Cambridge Observatory, deduced from a very great number of observations, being 4h. 44m. 29·6s. west of Greenwich, by applying this quantity to the comparisons made, and balancing the results with the errors of the chronometers on leaving Greenwich, the average rates during the passage out have been ascertained.

On Saturday evening, the 6th May, the chronometers were taken on board the "New Brunswick" steamer, which left this evening for St. John's, and arrived there on the Monday. The party were detained for some time at St. John's and Fredericton, waiting for the waters caused by the melting of the snow to subside. The chronometers were regularly wound up and compared during this time; but there were no means of ascertaining their rates until after the arrival of Captain Robinson and Lieutenant Pipon at their stations at the end of June. The whole passage from St. John's to the Grand Falls was made by water, they did not therefore receive any shock liable to affect them.

Captain Robinson commenced his observations at the Grand Falls, and kept with him—

Box Chronometer Heyes, 51.

Parkinson and Frodsham 2277 (used as standard).

Pocket Chronometers.

Arnold 2187. Molyneux 3147. Molyneux 3091.

Lieutenant Pipon proceeded by water to the mouth of Madawaska River, taking with him the other chronometers, viz.: —

Box Chronometers.

Arnold 341 (used as standard). Frodsham 2.

Pocket Chronometers.

Molyneux 3148. Molyneux 3226. Molyneux 3227.

Pocket chronometer Arnold 2111 was found to be quite useless; it frequently stopped after being wound up, and could not at all be depended on. No further mention is made of it in this report.

After observing with the transit instruments for time, the pocket chronometers at both stations were transmitted from one to the other three times, after being compared with the standards, for the purpose of getting the difference of longitude between the stations. They were placed in their own boxes, which were packed in one large box with horse-hair, &c., and were conveyed from one station to another, in a flat-bottomed boat, or bateau. The chronometers, when not travelling, were kept in as cool a place as possible, and were all compared with the standard, daily.

From the Grand Falls, Captain Robinson moved up to the mouth of the River St. Francis, and the same number of interchanges were made between St. Francis and Madawaska as had been made between Madawaska and the Grand Falls. After which, Lieutenant Pipon moved up the St. Francis to the outlet of Lake Pohenagamook, from which station interchanges were made with Captain Robinson at the mouth of the St. Francis. The only difference in the mode of conducting these interchanges from that described between the Grand Falls and Madawaska, was, that in this case bark canoes manned by Indians were used instead of bateaux. The navigation of the river being more difficult, owing to rapids and shallow places, in all cases the chronometers were accompanied by a non-commissioned officer of the Royal Sappers and Miners, whose duty it was to wind them up when detained more than twenty-four hours between the stations. Along the St. Francis it was also necessary to carry them by hand part of the way, across portages which had been cut to avoid some of the worst rapids.

After completing the necessary observations at the outlet of Lake Pohenagamook, Lieutenant Pipon proceeded by canoe down the St. Francis, and up the St. John, to the mouth of the Great Black River, where another astronomical station was established. Similar interchanges of chronometers were carried on between Black River and St. Francis, as before described, after which Captain Robinson removed from St. Francis, and passed up the St. John beyond Black River, to the Forks of the St. John, at which place another astronomical station was established. The season had now become so far advanced that it was found impracticable to carry on the comparisons in the same manner as heretofore. Lieutenant Pipon sent his chronometers by water to Captain Robinson for that purpose, but, the weather coming on very severe, the men were obliged to abandon their boats before arriving at the Forks, and the chronometers were carried by hand the remainder of the distance to that station, where they were detained until the month of January, when, the river being sufficiently frozen over for sleighs to travel on it, the chronometers were conveyed from one station to the other on the ice. The general result of all these comparisons for difference of longitude was most satisfactory, as was proved by the accurate bearing of the Sixty-Four Mile Trial Line, computed from these differences. But still it was found that some of the chronometers suffered severely from the extreme cold, particularly chronometers 3227 and 3091, which could not be relied upon during the last interchanges between the Forks and the Great Black River.

During the months of November, December, and January, the cold was most intense; on several occasions at Black River and the Forks the mercury in the thermometers had shrunk within the bulb, and the degree of cold could not be noted. At this time the box chronometers were carefully packed up in a box with woollen and horse-hair and kept in the wooden houses which had been put up for the officers, which were heated by stoves; and at Black River, when observing for time, they were not moved out, but the time was called and noted by one of the sappers remaining in the house which adjoined the observatory.

Arnold 341, and Frodsham 2, do not appear to have been sensibly affected by the cold, but Parkinson and Frodsham 2277, and Heyes 51, altered their rate considerably.

Up to this time, the chronometers had been moved about with the greatest care, and without any accident or probability of any great shock. It was now, however, necessary to carry Lieutenant Pipon's chronometers out of the woods by a new road to St. Thomas, and to remove them from thence by land-carriage to Rivière du Loup and Lake Pohenagamook, from whence the Trial Line was to be run early in March. They were carried to St. Thomas by hand, and were taken the remainder of the distance by cariole over a very rough road; they do not seem, however, to have suffered materially in consequence. Lieutenant Pipon's chronometers were carried with him along the Line as far as he went, and were afterwards taken out, by hand, to St. Francis Bridge and to Rivière du Loup and St. Thomas, in a spring-waggon. They were also carried by hand from St. Thomas to the North-West Branch Station, at the end of May, 1844, to be in time for the commencement of operations at the South-West Branch. There were no means of ascertaining the rates of the chronometers during their journeys.

Captain Robinson's chronometers had remained all this time at the North-West Branch.

In June 1844 the tracing of the Sixty-Four Mile Line having been most satisfactorily completed, the astronomical parties reassembled at the North-West Branch, when Captain Robinson established his station, and Lieutenant Pipon proceeded by water with his chronometers and instruments down to the North-West Branch, and up ths South-West Branch to find the point required by Treaty, where the parallel of latitude 46° 25′ intersects the South-West Branch. Having fixed, after three trials, upon a station near the required point, the pocket chronometers were again used in determining the difference of longitude between Captain Robinson's and Lieutenant Pipon's stations; and, all the necessary observations being made and the calculations deduced, the South Line was cut out during the month of August, after which Lieutenant Pipon returned to the North-West Branch, and proceeded from thence to Quebec, to which point the astronomical stations hitherto observed from were to be referred. The chronometers were carried by hand to St. Thomas, as before, and in a spring-waggon from thence to Quebec. After which Lieutenant Pipon's chronometers received very little shaking, until the completion of the work. And from this date a more complete detail of their rates can be given.

The length of time necessary to obtain interchanges of chronometers between Quebec and the North-West Branch, and the badness of the road which the chronometers would have to travel over, required that some other means should be adopted in obtaining the difference of longitude, and the system of observing signals simultaneously was resorted to. For this purpose Captain Robinson moved his observatory to the top of a hill about two miles west of the North-West Branch Station (which he connected with it by triangulation), from which hill he could see the dividing range between the St. Lawrence and St. John waters. This range was also visible from the heights of Quebec, on a part of which, near the Plains of Abraham, Lieutenant Pipon's astronomical station has been established. A party was sent under Serjeant M'Guckin, Royal Sappers and Miners, to select a convenient spot on the highest part of this range to fire flashes of gunpowder from; he was provided with a pocket chronometer adjusted to Quebec mean time, and was desired to fire flashes of gunpowder at ten minute intervals, commencing each evening at 8, and continuing until 10 P.M. The quantity of gunpowder used for each flash varied from a quarter to half a pound.

The hill from which the flashes were fired was nearly due east of Quebec, and about forty miles distant; being thickly wooded, and the party not being able to clear sufficiently to see off the summit in both directions, a high platform was erected, and a contrivance was also adopted for firing the flashes from the top of a high tree, by hoisting the charge, with a slow match attached to it, by means of a pulley fastened to a branch near the top.

The result of the flashing was very successful: on a clear night the flashes were seen distinctly from Quebec Observatory with the naked eye, but were generally observed with the telescope. Simultaneous observations were made on six different evenings, in which forty-six flashes were noted, the difference obtained by which agree very closely with each other. Captain Robinson and Lieutenant Pipon each afterwards made an attempt to ge the difference of longitude between their stations by transmission of their pocket chronometers; but the result so obtained was worthless compared with that deduced from the flashes.

These observations being completed, Captain Robinson left the woods, and, having selected a site on St. Helen's Island for an astronomical station to be prepared for him by the following spring, left his chronometers in charge of a non-commissioned officer of Sappers at Montreal, to be wound up and compared during the winter, and went to England. He took home with him one of the box chronometers (Heyes 51), which had been found to be most affected by change of temperature, and in the spring brought sidereal chronometer (Molyneux 943) in the place of it.

Lieutenant Pipon remained at Quebec during the winter, principally for the purpose of observing lunar transits for absolute longitude.

On Captain Robinson's return in the spring, interchanges of chronometers were made between the Quebec and St. Helen's stations; these were obtained with great facility, the chronometers being conveyed between the two places by the steamers which run daily.

From Quebec Lieutenant Pipon moved to the extreme west end of the North-East Boundary, where the 45th parallel intersects the St. Lawrence at St. Regis, and made interchanges between St. Helen's and St. Regis. In making these the chronometers were taken across between St. Regis and Cornwall, by canoe, and from thence to Montreal and back by the regular mail conveyance, which is part steamer and part coach.

Lieutenant Pipon's chronometers were not used for any further interchanges. Captain Robinson obtained the difference of longitude between his station at St. Helen's and Major Graham's station at Rouse's Point, by interchanges of chronometers in a similar manner to those described.

The difference of longitude between St. Regis and St. Helen's having been ascertained, and also that between Rouse's Point and St. Helen's, by the transmission of chronometers, an opportunity was afforded of testing the accuracy of these observations, and of getting a more correct determination of the difference of longitude between the astronomical stations at St. Regis and Rouse's Point, which were about sixty-four miles apart, and on the 45th parallel. From a hill near the village of St. Regis, and about half a mile from the station, a range of Highlands was seen extending to the south and south-east, and apparently from 30 to 40 miles distant.

Lieutenant Pipon suggested to Colonel Estcourt the probability of some part of this range being visible from the neighbour[illegible] of Major Graham's station at Rouse's Point; and, if so, the desirability of trying to obtain the difference of longitude by simultaneous observations of signals made at such a point.

Major Graham immediately concurred with this proposition, and having ascertained, by bearing and approximate distance, the position on the map of the highest and most suitable hill in the range, a party was sent from each of the stations, provided with gunpowder, rockets, &c.

Corporal Bastard, Royal Sappers and Miners, was furnished with a pocket chronometer, and received instructions to fire flashes at ten-minute intervals, commencing each night at 8h. 30m., and ending at 9h. 30m., St. Regis mean time. Major Graham's party was to commence firing at 8h. 25m. and every ten minutes until 9h. 35m. It was afterwards found better, on account of the long twilight, to commence later, and continue until 10h. 30m.

The flashes were fired by the chronometer time with great precision, as can [illegible] seen by reference to the observations. A rocket was also fired each night five minutes before commencing, and three or four were fired at five-minute intervals after the flashing was completed. The observations of these rockets were found to be not nearly so satisfactory as the flashes; very few corresponding observations were made, and they are rejected in computation for difference of longitude.

On the last three nights of the flashing, the moon was exceedingly bright, but this was not found materially to increase the difficulty of observing the flashes, which could be seen in that clear atmosphere very distinctly with the naked eye, although the distance of the hill (Lyon Mountain) on which they were fired was afterwards ascertained to be forty-three miles.

The difference of longitude between Rouse's Point and a station on the 45th parallel near Lake Memphramagog, taken up by Captain Robinson, was afterwards obtained in a similar manner by observations of flashes fired from the top of a mountain called Jay Peak.

The difference between Rouse's Point and a station on the 45th parallel at Richford, taken up by one of the American parties, and between Richford and Lake Memphramagog, were found in the same manner.

Comparisons of chronometers were made by the American astronomical parties between Rouse's Point and Albany, and again between Albany and Cambridge Observatory at Boston, by which means the whole of the astronomical stations along the Boundary and those of Quebec, St. Helen's, &c., are connected with Boston.

A copy of the observations of flashes between Quebec and the hill near the North-West Branch, called Lake Hill, and of those between St. Regis and Rouse's Point, are appended to this report; and also an abstracted account of the rates of the chronometers used by Lieutenant Pipon during the expedition, taken from the Book of Comparisons, in which the rates may be found rather more in detail, if required.

March, 1846. (Signed) JOHN H. PIPON,

Lieutenant, Royal Engineers.

SIDEREAL BOX CHRONOMETER FRODSHAM 2.

STATION.	Date.	RATES. Range during month. From	To	Average or mean of Rates determined during the month.	REMARKS.
	1843	s.	s.	s.	
Greenwich . .	April .	+0.4	—1·7	—0·4	At Greenwich Observatory, from March 28 to April 15.
On passage out	April & May	...	...	+1·95	
Madawaska . .	July .	+2·40	—2·24	—0·19	Kept in block-house; never moved out.
Ditto	August	—0·03	—2·54	—1·51	
Pohenagamook .	Sept. .	+1·63	—1·85	+0·26	In camp.
Black River . .	Oct. .	+2·10	—3·26	+0·04	In tent.
Ditto	Nov. .	+1·29	—1·30	+0·20	In log-hut.
Ditto	Dec. .				
	1844				
Ditto	Jan. .	+0·53	—4·85	—1·54	Ditto.
South - West Branch	July .	—0·74	—3·74	—1·44	Sent with pocket chronometers for comparison.
Quebec . . .	Sept. .	—1·54	—2·40	—1·88	In house.
Ditto	Oct. .	—0·00	—3·44	—1·69	Warmed by stove.
Ditto	Nov. .	—0·51	—6·00	—2·71	,,
Ditto	Dec. .	—0·64	—6·15	—3·49	,,
	1845				
Ditto	Jan. .	—1·35	—6·85	—2·70	,,
Ditto	Feb. .	—1·70	—9·24	—3·91	,,
Ditto	March	+0·45	—4·38	—2·77	,,
Ditto	April .	—0·20	—2·83	—1·90	,,
Ditto	May .	—0·72	—5·50	—2·17	Sent to St. Helen's with pocket chronometer for comparison for difference of longitude.
St. Regis . . .	June .	—0·10	—7·68	—3·78	
Ditto	July .	+1·08	—5·48	—2·88	
Russeltown . .	August	—3·64	—6·75	—5·16	

SIDEREAL BOX CHRONOMETER ARNOLD 341. (STANDARD.)

	1843				
Greenwich . .	April .	+0·6	—3·0	—0·77	Rate noted at Observatory from March 28 to April 15.
On passage out	April & May	...	...	—0·48	
Madawaska . .	July .	+0·34	—1·80	—0·39	Kept in block-house when not observing. Temperature very even.
Ditto	August	+0·25	—1·03	—0·41	
Lake Pohenagamook	August	—1·89	—2·53	—2·27	Kept in tent.
Ditto	Sept. .	—1·87	—3·26	—2·22	
Black River . .	Sept. .	—2·25	—2·25	—2·25	In tent.

SIDEREAL BOX CHRONOMETER 341—CONTINUED.

Station.	Date.	Rates. Range during month. From	To	Average or mean of Rates determined during the month.	Remarks.
	1843	s.	s.		
Black River . .	Oct. .	+0·16	—1·62	—0·52	In wooden house with stove. Temperature in house occasionally below zero, Fahrenheit.
Ditto	Nov. .	—0·13	—0·84	—0·48	
Ditto	Dec. .			—2·85	
	1844				
Ditto	Jan. .	—0·78	—3·54	—1·83	
South - West Branch	July .	+0·26	—0·25	—0·11	In tent.
Quebec . . .	Sept. .	—0·04	—0·83	—0·51	
Ditto	Oct. .	+0·14	—1·06	—0·29	
Ditto	Nov. .	+0·01	+0·64	—0·31	The chronometers at Quebec were kept in one of the soldiers' rooms in the cavalry barracks adjoining the Observatory. The temperature was generally tolerably even, but the standard was exposed to very severe cold when carried to the Observatory on nights that observations were being made.
Ditto	Dec. .	—0·34	—0·41	—0·36	
	1845				
Ditto	Jan. .	+0·20	—0·84	—0·47	
Ditto	Feb. .	+0·12	—0·48	—0·09	
Ditto	March	+0·12	+1·09	+0·61	
Ditto	April .	+1·39	+0·94	+1·36	
Ditto	May .	+2·06	+0·46	+1·20	
St. Regis . . .	June .	+1·61	+0·88	+1·25	At St. Regis and Russeltown the chronometers were kept in camp, in a box buried under ground, to protect them from the heat, which was very great.
Ditto	July .	+1·61	+0·89	+1·18	
Russeltown . .	August	+1·76	+1·17	+1·51	

MEAN TIME POCKET CHRONOMETER MOLYNEUX 3148.

	1843				
Greenwich . .	April .	...	...	—1·7	Rate, obtained from chronometers.
On passage out .	April .	...	...	—2·59	
Madawaska . .	July .	—0·74	— 3·98	—2·13	Travelling frequently between astronomical stations.
Ditto	August	—0·69	— 3·69	—1·75	
Lake Pohenagamook	Sept. .	—1·84	— 4·48	—3·55	Ditto.
Great Black River.	Oct. .	—1·53	—11·82	—5·67	Ditto.
Ditto	Nov.				
Ditto	Dec.	...	...	...	At Forks of the St. John.
	1844 Jan.				
North - West Branch	July .	+0·28	— 5·28	—2·97	Making interchanges.
Quebec . . .	Sept. .	—2·37	— 4·82	—3·96	Kept perfectly still.
Ditto	Oct. .	—0·81	— 5·25	—2·92	

Mean Time Pocket Chronometer Molyneux 3148—continued.

Stations.	Date.	Rates. Range during month. From	Rates. Range during month. To	Average or mean of Rates determined during the month.	Remarks.
	1844	s.	s.	s.	
Quebec	Nov.	—0·04	—10·30	—3·95	Kept perfectly still.
Ditto	Dec.	—0·27	—10·00	—4·80	Kept perfectly still.
	1845				
Ditto	Jan.	—0·58	—11·36	—4·36	Kept perfectly still.
Ditto	Feb.	—1·07	— 8·35	—4·13	Kept perfectly still.
Ditto	March	+1·35	— 8·28	—4·76	Kept perfectly still.
Ditto	April	—0·72	— 7·16	—3·66	Kept perfectly still.
Ditto	May	—0·17	— 4·06	—2·53	Travelling between Quebec and Montreal.
St. Regis	June	+0·07	—10·05	—4·20	Ditto, St. Regis and Montreal.
Ditto	July	+1·38	— 4·27	—1·56	

Mean Time Pocket Chronometer Molyneux 3226.

Stations.	Date.	From	To	Average	Remarks.
	1843				
Greenwich	April	...	...	— 4·8	
On passage out	April	...	...	— 4·50	
Madawaska	July	+ 3·35	+ 0·22	+ 1·81	Travelling between astronomical stations frequently.
Ditto	August	+ 2·96	+ 2·43	+ 2·62	Travelling between astronomical stations frequently.
Pohenagamook	Sept.	+ 4·93	+ 3·15	+ 3·78	Ditto.
Black River	Oct.	+ 3·83	+ 2·82	+ 3·29	
Ditto	Nov. Dec. 1844 Jan.	...	...	...	At Forks of St. John.
South - West Branch	July	+ 9·09	+ 8·53	+ 8·71	Travelling between stations.
Quebec	Sept.	+10·31	+12·79	+11·64	An Indian range with Serjeant McGuckin.
Ditto	Oct.	+13·15	+12·37	+12·92	
Ditto	Nov.	+15·08	+12·45	+14·02	
Ditto	Dec.	+16·09	+ 8·72	+13·89	
	1845				
Ditto	Jan.	+16·02	+14·27	+15·49	At Quebec.
Ditto	Feb.	+19·97	+12·79	+16·14	
Ditto	March.	+19·58	+14·15	+16·88	
Ditto	April	+19·92	+15·37	+16·84	
Ditto	May	+17·33	+15·37	+16·52	Travelling between Quebec and Montreal.
St. Regis	June	+22·97	+11·77	+17·37	Ditto, between Montreal and St. Regis.
Ditto	July	+15·96	+11·04	+12·75	

MEAN TIME POCKET CHRONOMETER MOLYNEUX 3227.

STATION.	Date.	Rates. Range during month. From	To	Average or mean of Rates determined during the month.	REMARKS.
	1843	s.	s.	s.	
Greenwich . .	April .	...	...	—0·5	
On passage out .	April .	...	...	− 2·02	
Madawaska . .	July .	+ 3·46	+0·91	+2·02	Travelling frequently between astronomical stations.
Ditto	August	+ 2·81	+0·00	+1·35	Ditto.
Pohenagamook .	Sept. .	+ 8·97	+3·51	+5·51	Ditto.
Black River . .	Oct. .	+ 8·87	+6·29	+7·29	Ditto.
	Nov. Dec. 1844 Jan.	...	...	...	At Forks of St. John.
South - West Branch	July .	+ 6·06	—2·18	+3·60	Travelling between stations.
Quebec . . .	Sept. .	+ 1·65	—1·89	—0·14	
Ditto	Oct. .	+ 3·46	+0·37	+1·54	
Ditto	Nov. .	+ 7·96	+2·92	+4·72	
Ditto	Dec. .	+ 9·96	+3·51	+5·75	
	1845				
Ditto	Jan. .	+ 7·72	+3·94	+5·80	
Ditto	Feb. .	+12·66	+4·33	+7·02	
Ditto	March	+ 7·14	+1·50	+5·70	
Ditto	April .	+ 6·11	—1·43	+3·71	
Ditto	May .	+ 5·00	+2·61	+3·91	
St. Regis . . .	June .	+ 7·31	+3·19	+4·90	
Ditto	July .	+ 6·06	+7·31	+6·68	With Corporal Bastard on Lyon Mountain.

(Signed) J. H. PIPON,

Lieutenant, Royal Engineers.

Observations for Difference of Longitude between the Astronomical Stations at Quebec and Lake Hill, near North-West Branch, by flashes of gunpowder fired on the top of an intermediate hill.

Name of Station.	Date, Hour and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	Sidereal Time of Observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	M. S.	H. M. S.	M. S.
Quebec . .	Sept. 23, 8 0	20 6 58	0 11·53 fast	20 6 46·47	4 48·82
Lake Hill .		20 19 30	2 5·29 slow	20 11 35·29	
Quebec . .	" " 8 10	20 17 34	0 11·53 fast	20 17 22·47	4 57·32
Lake Hill .		20 20 14·5	2 5·29 slow	20 22 19·79	* reject
Quebec . .	" " 8 20	20 27 5·6	0 11·53 fast	20 26 54·07	4 47·72
Lake Hill .		20 29 36·5	2 5·29 slow	20 31 41·79	
Quebec . .	" " 8 30	20 36 59·5	0 11·53 fast	20 36 47·97	4 48·32
Lake Hill .		20 39 31	2 5·29 slow	20 41 36·29	
Quebec . .	" " 8 40	20 48 14·1	0 11·53 fast	20 48 2·57	4 47·22
Lake Hill .		20 50 44·5	2 5·29 slow	20 52 49·79	
Quebec . .	" " 9 0	21 7 22·3	0 11·53 fast	21 7 10·77	4 47·52
Lake Hill .		21 9 53	2 5·29 slow	21 11 58 29	
Quebec . .	" " 9 10	21 16 55·3	0 11·53 fast	21 16 43·97	4 48·32
Lake Hill .		21 19 27	2 5·29 slow	21 21 32·29	
Quebec . .	" " 9 20	21 27 21	0 11·53 fast	21 27 9·46	4 47·82
Lake Hill .		21 29 52	2 5·29 slow	21 31 57·29	
Quebec . .	" " 9 30	21 36 44·2	0 11·53 fast	21 36 32·67	4 48·12
Lake Hill .		21 39 15·5	2 5·29 slow	21 41 20·79	
Quebec . .	" " 9 40	21 47 2·5	0 11·53 fast	21 46 50·97	4 47·82
Lake Hill .		21 49 33·5	2 5·29 slow	21 51 38·79	
Quebec . .	" " 9 50	21 58 43·5	0 11·53 fast	21 58 39·97	4 47·32
Lake Hill .		22 1 14	2 5·29 slow	22 3 19·29	

Sum of 10 observations . . . . 10) 47 59·00

Mean difference of longitude by flashes observed on September 23 = 4 47 90

Quebec . .	Sept. 25, 8 0	20 16 9·5	0 9·91 fast	20 15 59·59	4 46·62
Lake Hill .		20 18 40	2 6·21 slow	20 20 46·21	
Quebec . .	" " 8 10	20 28 2·6	0 9·91 fast	20 27 52·69	4 46·52
Lake Hill .		20 30 33	2 5·29 slow	20 32 39·21	
Quebec . .	" " 8 40	20 58 54	0 9·91 fast	20 58 44·09	4 46·62
Lake Hill .		21 1 24·5	2 6·21 slow	21 3 30·71	
Quebec . .	" " 8 50	22 5 31·4	0 9·91 fast	22 5 21·49	4 46·22
Lake Hill .		22 8 1·5	2 6·21 slow	22 10 7·71	

Sum of 4 observations . . . . 4) 19 5·98

Mean difference of longitude by flashes observed on September 25 = 4 46·49

* Probably an error of 10 seconds.

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	Sidereal Time of Observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	H. S.	H. M. S.	M. S.
Quebec .	Sept. 27, 8 20	20 42 35·6	0 9·10 fast	20 42 25·50	4 45·65
Lake Hill .		20 45 4	2 7·15 slow	20 47 11·15	
Quebec .	„ „ 8 30	20 53 13·9	0 9·10 fast	20 53 4·80	4 46·35
Lake Hill .		20 55 44	2 7·15 slow	20 57 51·15	
Quebec .	„ „ 8 50	21 13 19·5	0 9·10 fast	21 13 10·40	4 46·25
Lake Hill .		21 15 49·5	2 7·15 slow	21 17 56·65	
Quebec .	„ „ 9 20	21 43 23·4	0 9·10 fast	21 43 14·30	4 46·35
Lake Hill .		21 45 53·5	2 7·15 slow	21 48 0·65	
Quebec .	„ „ 9 40	22 3 23	0 9·10 fast	22 3 13·90	4 45·75
Lake Hill .		22 5 52·5	2 7·15 slow	22 7 59·65	
Quebec .	„ „ 9 50	22 13 31·7	0 9·10 fast	22 13 22·60	4 46·05
Lake Hill .		22 16 1·5	2 7·15 slow	22 18 8·65	
Quebec .	„ „ 10 0	22 22 49·5	0 9·10 fast	22 22 40·40	4 45·75
Lake Hill .		22 25 19	2 7·15 slow	22 27 26·15	

Sum of 7 observations . . . . 7) 33 22·15

Mean difference of longitude by flashes observed on September 27 = 4 46·02

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	Sidereal Time of Observation.	Difference of Longitude.
Quebec .	Sept. 28, 8 0	20 26 52·2	0 8·35 fast	20 26 43·85	4 46·38
Lake Hill .		20 29 22	2 8·23 slow	20 31 30·23	
Quebec .	„ „ 8 10	20 36 50·5	0 8·35 fast	20 36 42·15	4 45·58
Lake Hill .		20 39 19·5	2 8·23 slow	20 41 27·73	
Quebec .	„ „ 8 20	20 50 9·6	0 8·35 fast	20 50 1·25	4 45·98
Lake Hill .		20 52 39	2 8·23 slow	20 54 47·23	
Quebec .	„ „ 8 40	21 7 25·8	0 8·35 fast	21 7 17·45	4 45·78
Lake Hill .		21 9 55	2 8·23 slow	21 12 3·23	
Quebec .	„ „ 8 50	21 17 30·5	0 8·35 fast	21 17 22·15	4 46·08
Lake Hill .		20 20 0	2 8·23 slow	21 22 8·23	
Quebec .	„ „ 9 0	21 27 26·7	0 8·35 fast	21 27 18·35	4 45·88
Lake Hill .		21 29 56	2 8.23 slow	21 32 4·23	
Quebec .	„ „ 9 10	21 37 19·7	0 8·35 fast	21 37 11·35	4 45·88
Lake Hill .		21 39 49	2 8·23 slow	21 41 57·23	
Quebec .	„ „ 9 20	21 47 6·4	0 8·35 fast	21 46 58·05	4 45·68
Lake Hill .		21 49 35·5	2 8·23 slow	21 51 43·73	
Quebec .	„ „ 9 30	21 57 9·7	0 8·35 fast	21 57 1·35	4 45·88
Lake Hill .		21 59 39	2 8·23 slow	22 1 47·23	
Quebec .	„ „ 9 40	22 7 10·8	0 8·35 fast	22 7 2·45	4 45·78
Lake Hill .		22 9 40	2 8·23 slow	22 11 48·23	
Quebec .	„ „ 9 50	22 17 31·3	0 8·35 fast	22 17 22·95	4 45·28
Lake Hill .		22 20 0	2 8·23 slow	22 22 8·23	
Quebec .	„ „ 10 0	22 27 18·1	0 8·35 fast	22 27 9·75	4 44·98
Lake Hill .		22 29 46·5	2 8·23 slow	22 31 54·73	

Sum of 12 observations . . . . 12) 57 9·16

Mean difference of longitude by flashes observed on September 28 = 4 45·76

Name of Station.	Date, Hour, and Minute.		Flashes observed.	Error of Chronometers on Sidereal Time of Stations.	Sidereal Time of Observation.	Difference of Longitude.
	1844	H. M.	H. M. S.	M. S.	H. M. S.	M. S.
Quebec . .	Sept. 30,	8 10	20 44 36·4	0 8·26 fast	20 44 28·14	4 45·67
Lake Hill .			20 47 3	2 10·81 slow	20 49 13·81	
Quebec . .	" "	8 20	20 55 3·5	0 8·26 fast	20 54 55·24	4 45·57
Lake Hill .			20 57 30	2 10·81 slow	20 59 40·81	
Quebec . .	" "	8 40	21 15 19·5	0 8·26 fast	21 15 11·24	4 45·57
Lake Hill .			21 17 46	2 10·81 slow	21 19 56·81	
Quebec . .	" "	8 50	21 25 29·6	0 8·26 fast	21 25 21·34	4 44·47
Lake Hill .			21 27 55	2 10·81 slow	21 30 5·81	
Quebec . .	" "	9 0	21 35 25·6	0 8·26 fast	21 35 17·34	4 45·47
Lake Hill .			21 37 52	2 10·81 slow	21 40 2·81	
Quebec . .	" "	9 10	21 45 27·3	0 8·26 fast	21 45 19·04	4 44·77
Lake Hill .			21 47 53	2 10·81 slow	21 50 3·81	
Quebec . .	" "	9 20	21 55 26·4	0 8·26 fast	21 55 18·14	4 45·67
Lake Hill .			21 57 53	2 10·81 slow	22 0 3·81	
Quebec . .	" "	9 50	22 25 47·6	0 8·26 fast	22 25 39·34	4 45·47
Lake Hill .			22 28 14	2 10·81 slow	22 30 24·81	

Sum of 8 observations . . . . 8) 38 2·66

Mean difference of longitude by flashes observed on September 30 = 4 45·33

Quebec . .	Oct. 2,	8 20	21 1 16·2	0 8.26 fast	21 1 7·94	4 46·1
Lake Hill .			21 3 40·5	2 13·45 slow	21 5 53·95	
Quebec . .	" "	8 30	21 11 7·5	0 8·26 fast	21 10 59·24	4 46·71
Lake Hill .			21 13 32·5	2 13·45 slow	21 15 45·95	
Quebec . .	" "	8 40	21 20 53·8	0 8·26 fast	21 20 45·54	4 46·41
Lake Hill .			21 23 18·5	2 13·45 slow	21 25 31·95	
Quebec . .	" "	8 50	21 31 54·6	0 8·26 fast	21 31 46·34	4 46·61
Lake Hill .			21 34 19·5	2 13·45 slow	21 36 32·95	
Quebec . .	" "	9 0	21 41 38·3	0 8·26 fast	21 41 30·04	4 46·41
Lake Hill .			21 44 3	2 13·45 slow	21 46 16·45	

Sum of observations . . . . 5) 23 52·15

Mean difference of longitude by flashes observed on October 2 = 4 46·43

ABSTRACT OF FOREGOING.

				M.	S.
September 23,	mean result of corresponding observations of	10	flashes	=4	47·90
" 25,	" "	14	"	=4	46·49
" 27,	" "	7	"	=4	46·02
" 28,	" "	12	"	=4	45 76
" 30,	" "	8	"	=4	45·33
October 2,	" "	5	"	=4	46·43
				6)	277·93

Astronomical Station at Lake Hill, east of Astronomical Station at Quebec 4 46·32

(Signed) JOHN H. PIPON,

Lieutenant, Royal Engineers.

The flashes observed at St. Regis were noted with the sidereal chronometer Frodsham 2, which had to be carried each evening from the Observatory to the top of the hill, a distance of rather more than half a mile, but was compared with the standard before leaving and after returning to the Observatory.

The error of chronometer Frodsham 2 is deduced as under :—

Date, Hour, and Minute.	Time by Standard Chronometer.	From Transit Book. Stand. Chron. fast.	True Sidereal Time of Station.	Time by Frodsh. No. 2.	Frodsham No. 2, fast.	Mean Error at Time of Observation.
H. M.	H. M. S.	M. S.	H. M. S.	H. M.	M. S.	S. H. M.
July 14, 7 10	14 40 8·5	1 25·87	14 38 42·63	14 39	0 17·37	17·16 at 9 15
„ 10 10	17 37 9·0	1 26·07	17 35 42·93	17 36	17·07	
„ 15 7 55	15 25 11·0	1 27·53	15 23 43·47	15 24	16·53	16·25 at 9 40
„ 11 20	18 51 11·8	1 27·79	18 49 44·01	18 50	15·99	
„ 17 8 0	15 42 18·7	1 29·44	15 40 49·26	15 41	10·74	10·42 at 9 50
„ 11 40	19 23 19·5	1 29·60	19 21 49·90	19 23	10·10	
„ 18 8 20	16 5 25·4	1 30·35	16 3 55·05	16 4	4·95	4·77 at 9 30
„ 11 40	19 23 26·0	1 30·47	19 21 55·33	19 22	4·47	
„ 19 8 5	15 53 30·5	1 31·24	15 51 59·26	15 52	0·74	0·30 at 9 50
„ 11 40	19 22 31·5	1 31·39	19 21 0·11	19 21	Slow 0·11	

OBSERVATIONS for Difference of Longitude between the Astronomical Stations of Lieutenant Pipon, Royal Engineers, at St. Regis, and Major Graham, United States' Topographical Engineers, at Rouse's Point, by flashes of gunpowder and rockets fired from the top of Lyon Mountain, New York.

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	Sidereal Time of Observation.	Difference of Longitude.
	H. M.	H. M. S.	H. M. S.	H. M. S.	M. S.
St. Regis . .	July 14, 8 45	D16 16 2·0	0 0 17·16 fast	16 15 44·84	+5 14·55
* Rouse's Point		13 39 17·8	4 49 24·18 „	16 20 59·39	+ reject.
			(On mean time.)		
St. Regis . .	„ „ 8 50	16 21 3·5	0 0 17·16 „	16 20 46·34	5 13·67
* Rouse's Point		13 44 17·6	4 49 24·18 „	16 26 00·01	
St. Regis . .	„ „ 8 55	16 26 3·5	0 0 17·16 „	16 25 46·34	5 13·49
* Rouse's Point		13 49 16·6	4 49 24·18 „	16 30 59·83	
St. Regis . .	„ „ 9 0	16 31 5·0	0 0 17·16 „	16 30 47·84	5 13·91
* Rouse's Point		13 54 17·7	4 49 24·18 „	16 36 01·75	
St. Regis . .	„ „ 9 5	16 36 6·0	0 0 17·16 „	16 35 48·84	5 13·43
Rouse's Point		16 44 36·2	0 3 33·93 „	16 41 02·27	
St. Regis . .	„ „ 9 10	D16 41 6·5	0 0 17·16 „	16 40 49·34	5 13·73
Rouse's Point		16 49 37·0	0 3 33·93 „	16 46 03·07	
St. Regis . .	„ „ 9 15	16 46 7·3	0 0 17·16 „	16 45 50·14	5 13·98
* Rouse's Point		14 09 17·6	4 49 24·18 „	16 51 04·12	
				Carried forward . .	31 22·21

* Those observations marked thus (*) were noted with a mean time chronometer. Those marked thus (D) have not been quite so well observed as the others.

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	Sidereal Time of Observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	H. M. S.	H. M. S.	M. S.
				Bro^t. forward	31 22·21
St. Regis . .	July 14, 9 20	16 51 8·0	0 0 17·16 fast	16 50 50·84	5 13·43
Rouse's Point		16 59 58·2	0 3 33·93 „	16 56 04·27	
St. Regis . .	„ „ 9 25	16 56 8·5	0 0 17·16 „	16 55 51·34	5 13·73
Rouse's Point		17 4 39·0	0 3 33·93 „	17 1 05·07	
St. Regis . .	„ „ 9 30	17 1 10·3	0 0 17·16 „	17 0 53·14	5 13·43
Rouse's Point		17 9 40·5	0 3 33·93 „	17 6 6·57	
	Sum of 9 observations			9)	47 2·80
	Mean difference of longitude by flashes observed on July 14 =				5 13·64
St. Regis . .	July 15, 8 30	16 4 52 7	0 0 16·25 fast	16 4 36·45	5 13·67
* Rouse's Point		13 24 13·0	4 49 22·73 „	16 9 50·12	
St. Regis . .	„ „ 8 35	16 9 53·4	0 0 16·25 „	16 9 37·15	5 13·59
* Rouse's Point		13 25 12·8	4 49 22·73 „	16 14 50·74	
St. Regis . .	„ „ 8 40	16 14 54·5	0 0 16·25 „	16 14 38·25	5 13·45
Rouse's Point		16 23 26·3	0 3 34·60 „	16 19 51·70	
St. Regis . .	„ „ 8 45	16 19 55·5	0 0 16·25 „	16 19 39·25	5 13·35
Rouse's Point		16 28 27·2	0 3 34·60 „	16 25 52·60	
St. Regis . .	„ „ 8 50	16 24 56	0 0 16·25 „	16 24 39·75	5 13·70
* Rouse's Point		13 44 13	4 49 22·73 „	16 29 53·45	
St. Regis . .	„ „ 8 55	16 29 56·3	0 0 16·25 „	16 29 40·05	5 13·45
Rouse's Point		16 38 28·1	0 3 34·60 „	16 34 53·50	
St. Regis . .	„ „ 9 0	16 34 58·6	0 0 16·25 „	16 34 42·35	5 13·35
Rouse's Point		16 43 30·3	0 3 34·60 „	16 39 55·70	
St. Regis . .	„ „ 9 5	16 39 59	0 0 16·25 „	16 39 42·75	5 13·45
Rouse's Point		16 48 30·8	0 3 34·60 „	16 44 56·20	
St. Regis . .	„ „ 9 10	16 44 59·2	0 0 16·25 „	16 44 42·95	5 13·35
Rouse's Point		16 53 30·9	0 3 34·60 „	16 49 56·30	
St. Regis . .	„ „ 9 15	16 50 0·3	0 0 16·25 „	16 49 44·05	5 13·35
Rouse's Point		16 58 32	0 3 34·60 „	16 54 57·40	
St. Regis . .	„ „ 9 20	16 55 1·5	0 0 16·25 „	16 54 45·25	5 13·65
Rouse's Point		17 3 33·5	0 3 34·60 „	16 59 58 90	
St. Regis . .	„ „ 9 25	17 0 2·3	0 0 16·25 „	16 59 46·05	5 13·45
Rouse's Point		17 8 34·1	0 3 34·60 „	17 4 59·50	
St. Regis . .	„ „ 9 30	17 5 3	0 0 16·25 „	17 4 46·75	5 13·15
Rouse's Point		17 13 34·5	0 3 34 60 „	17 9 59·60	
St. Regis . .	„ „ 9 35	17 10 3·5	0 0 16·25 „	17 9 47·25	5 13·45
Rouse's Point		17 18 35·3	0 3 34·60 „	17 15 00·70	
St. Regis . .	„ „ 9 40	17 15 4·8	0 0 16·25 „	17 14 48·55	5 13·65
Rouse's Point		17 23 36·8	0 3 34·60 „	17 20 2·20	
St. Regis . .	„ „ 9 45	17 20 5 4	0 0 16·25 „	17 19 49·15	5 13·60
Rouse's Point		17 28 37·35	0 3 34·60 „	17 25 2·75	
St. Regis . .	„ „ 9 50	17 25 6·5	0 0 16·25 „	17 24 50·25	5 13·25
Rouse's Point		17 33 38·1	0 3 34·60 „	17 30 3·50	
				Carried forward .	88 48·91

* Those observations marked thus (*) were noted with a mean time chronometer.

Name of Station.	Date, Hour, and Minute.	Flash observed.	Errors of Chronometers on Sidereal Time of Station.	Sidereal Time of observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	H. M. S.	H. M. S.	M. S.
				Brot. forward	88 48 91
St. Regis . .	July 15, 10 0	17 35 ·2	0 16·25 fast	17 34 51·95	5 13·45
Rouse's Point		17 43 40	3 34·60 „	17 40 5·40	
St. Regis .	„ „ 10 5	17 40 8 8	0 16·25 „	17 39 52·55	5 13·45
Rouse's Point		17 48 40·6	3 34·60 „	17 45 06·00	
St. Regis . .	„ „ 10 10	17 45 9·3	0 16·25 „	17 44 53·05	5 13·65
Rouse's Point		17 53 41·3	3 34·60 „	17 50 6·70	
St. Regis . .	„ „ 10 15	17 50 10 5	0 16·25 „	17 49 54·25	5 13·45
Rouse's Point		17 58 42·3	3 34·60 „	17 55 7·70	
St. Regis . .	„ „ 10 20	17 55 11·4	0 16·25 „	17 54 55·15	5 13·55
Rouse's Point		18 3 43·3	3 34·60 „	18 0 8·70	
St. Regis . .	„ „ 10 25	18 0 12	0 16·25 „	17 59 55·75	5 13·55
Rouse's Point		18 8 43·9	3 34·60 „	18 5 9·30	
St. Regis . .	„ „ 10 30	18 5 13	0 16·25 „	18 4 56·75	5 13·65
Rouse's Point		18 13 45	3 34·60 „	18 10 10·40	
St. Regis . .	„ „ 10 35	18 10 33	0 16·25 „	18 10 16·75	5 12·45
Rouse's Point	(Rocket burst.)	18 19 3·8	3 34 60 „	18 15 29·20	(reject.)
St. Regis . .	„ „ 10 40	D 18 15 35	0 16·25 „	18 15 15·75	
Rouse's Point	(Rocket burst.)				
Sum of 24 observations					125 23·66
Mean difference of longitude by flashes observed on July 15 =					5 13·48
St. Regis . .	July 17, 9 0	16 42 44·5	0 10 42 fast	16 42 34·08	5 13 44
Rouse's Point		16 51 21·4	3 33·88 „	16 47 47 52	
St. Regis . .	„ „ 9 5	16 47 46·5	0 10·42 „	16 47 36·08	5 13·54
Rouse's Point		16 56 23·5	3 33·88 „	16 52 49·62	
St. Regis . .	„ „ 9 10	16 52 45·3	0 10·42 „	16 52 34·88	5 13·44
Rouse's Point		17 1 22·2	3 33·88 „	16 57 48·32	
St. Regis . .	„ „ 9 15	16 57 46	0 10·42 „	16 57 35·58	5 13·74
Rouse's Point		17 6 23·2	3 33·88 „	17 2 49·32	
St. Regis . .	„ „ 9 20	D 17 2 47	0 10·42 „	17 2 36·58	5 13·64
Rouse's Point		17 11 24·1	3 33·88 „	17 7 50 22	
St. Regis . .	„ „ 9 25	17 7 48	0 10·42 „	17 7 37·58	5 13·54
Rouse's Point		17 16 25	3 33·88 „	17 12 51·12	
St. Regis . .	„ „ 9 30	17 12 48·5	0 10 42 „	17 12 38·08	5 13·64
Rouse's Point		17 21 25·6	3 33·88 „	17 17 51·72	
St. Regis . .	„ „ 9 35	17 17 50·4	0 10·42 „	17 17 39·98	5 13·34
Rouse's Point		17 26 27·2	3 33·88 „	17 22 53·32	
St. Regis . .	„ „ 9 40	17 22 51·2	0 10·42 „	17 22 40·78	5 13·44
Rouse's Point		17 31 28·1	3 33 88 „	17 27 54·22	
St Regis . .	„ „ 9 45	17 27 51	0 0 10·42 „	17 27 40·58	5 13·66
*Rouse's Point		14 39 07·8	4 49 18·84 „	17 32 54·24	
St. Regis . .	„ „ 9 50	17 32 56·2	0 0 10·42 „	17 32 45·78	+5 16·20
*Rouse's Point		14 44 14·7	4 49 18·84 „	17 38 01·98	+(reject.)
Carried forward .					52 15·42

* Those observations marked thus (*) were noted with a mean time chronometer.
Marked thus (D) have not been quite so well observed as the others.

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Station.	Sidereal Time of Observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	H. M. S.	H. M. S.	M. S.
				Brot. forward.	52 15·42
St. Regis . .	July 17, 10 0	17 42 54·4	0 0 10·42 fast	17 42 43·98	5 13·54
Rouse's Point		17 51 31·4	0 3 33·88 "	17 44 57·52	
St. Regis . .	" " 10 5	17 47 55	0 0 10·42 "	17 47 44·58	5 13·45
* Rouse's Point		4 49 08·3	4 49 18·14 "	17 52 58 03	
St. Regis . .	" " 10 10	17 52 56·5	0 0 10 42 "	17 52 46·08	5 13·54
Rouse's Point		18 5 33·5	0 0 33·88 "	17 57 59·62	
St. Regis . .	" " 10 20	18 3 58	0 0 10·42 "	18 3 47·58	5 13·61
* Rouse's Point		15 14 09	4 49 18 84 "	18 8 01·19	
St. Regis . .	" " 10 25	18 7 58·7	0 0 10·42 "	18 7 48·28	5 13·54
Rouse's Point		18 16 35·7	0 3 33·88 "	18 13 1·82	
St. Regis . .	" " 10 30	18 12 58	0 0 10·42 "	18 12 47·58	5 13·54
Rouse's Point		18 21 35	0 3 33·88 "	18 18 01·12	
	Sum of 16 observations				16) 83 36·64
	Mean difference of longitude by flashes observed on July 17 =				5 13·5?
St. Regis . .	July 18, 9 0	16 46 30·6	0 0 4·77 fast	16 46 25·83	+5 14·31
* Rouse's Point		13 54 0·4	4 49 18·30 "	16 51 40·14	+ reject.
St. Regis . .	" " 9 5	16 51 30·0	0 4·77 "	16 51 25·23	5 12·67
Rouse's Point		17 00 13	3 35·10 "	16 56 37·90	
St. Regis . .	" " 9 10	16 56 31·4	0 4·77 "	16 56 26·63	5 12·37
Rouse's Point		17 05 14·1	3 35·10 "	17 1 39·00	
St. Regis . .	" " 9 15	17 01 31·6	0 4·77 "	17 1 26·83	5 13·07
Rouse's Point		17 10 15	3 35·10 "	17 6 39·90	
St. Regis . .	" " 9 20	17 06 32·5	0 4·77 "	17 6 27·73	5 12·87
Rouse's Point		17 15 15·7	3 35·10 "	17 11 40·60	
St. Regis . .	" " 9 25	17 11 34	0 4·77 "	17 11 29·23	5 12·77
Rouse's Point		17 20 17·1	3 35·10 "	17 16 42·00	
St. Regis . .	" " 9 30	17 16 34	0 4·77 "	17 16 29·23	5 13·17
Rouse's Point		17 25 17·5	3 35·10 "	17 21 42·40	
St. Regis . .	" " 9 35	17 21 35·2	0 4·77 "	17 21 30·43	5 13·07
Rouse's Point		17 30 18·6	3 35·10 "	17 26 43·50	
St. Regis . .	" " 9 40	17 26 36	0 4·77 "	17 26 31·23	5 12·97
Rouse's Point		17 35 19·3	3 35·10 "	17 31 44·20	
St. Regis . .	" " 9 45	D 17 31 36·5	0 4·77 "	17 31 31·73	5 13·17
Rouse's Point		17 40 20	3 35·10 "	17 36 44·90	
St. Regis . .	" " 9 50	17 36 39·4	0 4·77 "	17 36 34·63	5 12·87
Rouse's Point		17 45 22·6	3 35 10 "	17 41 47·50	
St. Regis . .	" " 10 0	17 46 40·3	0 4·77 "	17 46 35·53	5 12·37
Rouse's Point		17 55 23	3 35·10 "	17 51 47·90	
St. Regis . .	" " 10 5	17 51 40·5	0 4·77 "	17 51 35·73	5 12·67
Rouse's Point		18 00 23·5	3 35·10 "	17 56 48·40	
St. Regis . .	" " 10 10	17 56 41·2	0 04·77 "	17 56 36·43	5 12·87
Rouse's Point		18 05 24·4	3 35·10 "	18 01 49·30	
				Carried forward .	67 46·91

* Those observations marked thus (*) were noted with a mean time chronometer. Marked thus (D) have not been quite so well observed as the others.

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	Sidereal Time of Observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	M. S.	H. M. S.	M. S.
				Brot. forward	67 46·91
St. Regis . .	July 18, 10 15	18 01 42·4	0 04·77 fast	18 01 37·63	5 12·77
Rouse's Point		18 10 25·5	3 35·10 „	18 06 50·40	
St. Regis . .	„ „ 10 20	18 06 43	0 04·77 „	18 06 38·23	5 12·67
Rouse's Point		18 15 26	3 35·10 „	18 11 50·90	
	Sum of 15 observations			15)	78 12·35
	Mean difference of longitude by flashes observed on July 18=				5 12·82
St. Regis . .	July 19, 9 10	D17 01 18	0 00·30 fast	17 01 17·70	+5 12·26
Rouse's Point		17 10 06	3 36·04 „	17 06 29·96	+ reject.
St. Regis . .	„ „ 9 15	17 06 18·5	0 00·30 „	17 06 18·20	5 12·46
Rouse's Point		17 15 06·7	3 36·04 „	17 11 30·66	
St. Regis . .	„ „ 9 20	17 11 19·2	0 00·30 „	17 11 18·90	5 12·56
Rouse's Point		17 20 07·5	3 36·04 „	17 16 31·46	
St. Regis . .	„ „ 9 25	17 16 19·8	0 00·30 „	17 16 19·50	5 12·76
Rouse's Point		17 25 08·3	3 36·04 „	17 21 32·26	
St. Regis . .	„ „ 9 30	17 21 20·4	0 00·30 „	17 21 20·10	5 12·66
Rouse's Point		17 30 08·8	3 36·04 „	17 26 32·76	
St. Regis . .	„ „ 9 35	17 26 21·3	0 00·30 „	17 26 21·00	5 12·46
Rouse's Point		17 35 09·5	3 36·04 „	17 31 33·46	
St. Regis . .	„ „ 9 40	17 31 32·5	0 00·30 „	17 31 22·20	5 12·26
Rouse's Point		17 40 10·5	3 36·04 „	17 36 34·46	
St. Regis . .	„ „ 9 45	17 36 22·6	0 00·30 „	17 36 22·30	5 12·66
Rouse's Point		17 45 11	3 36·04 „	17 41 34·96	
St. Regis . .	„ „ 9 50	17 41 23·8	0 00·30 „	17 41 23·50	5 12·76
Rouse's Point		17 50 12·3	3 36·04 „	17 46 36·26	
St. Regis . .	„ „ 9 55	17 46 24·4	0 00·30 „	17 46 24·10	5 12·86
Rouse's Point		17 55 13	3 36·04 „	17 51 36·96	
St. Regis . .	„ „ 10 0	D17 51 26	0 00·30 „	17 51 25·70	+5 12·26
Rouse's Point		18 00 14	3 36·04 „	17 56 37·96	+ reject.
St. Regis . .	„ „ 10 5	17 56 26·3	0 00·30 „	17 56 26·00	5 12·66
Rouse's Point		18 05 14·7	3 36·04 „	18 01 38·66	
St. Regis . .	„ „ 10 10	18 01 26·8	0 00·30 „	18 01 26·50	5 12·76
Rouse's Point		18 10 15·3	3 36·04 „	18 06 39·26	
St. Regis . .	„ „ 10 15	18 06 27·5	0 00·30 „	18 06 27·20	5 12·86
Rouse's Point		18 15 16·1	3 36·04 „	18 11 40·06	
St. Regis . .	„ „ 10 20	18 11 28·5	0 00·30 „	18 11 28·20	5 12·76
Rouse's Point		18 20 17	3 36·04 „	18 16 40·96	
St. Regis . .	„ „ 10 25	18 16 29·0	0 00·30 „	18 16 28·70	5 13·06
Rouse's Point		18 25 17·8	3 36·04 „	18 21 41·76	
St. Regis . .	„ „ 10 30	18 21 30·0	0 00·30 „	18 21 29·70	5 12·86
Rouse's Point		18 30 18·6	3 36·04 „	18 26 42·56	
St. Regis . .	„ „ 10 35	18 26 30·5	0 00·30 „	18 26 30·20	5 13·16
Rouse's Point		18 35 19·4	3 36·04 „	18 31 43·36	
				Carried forward .	83 23·56

The two flashes marked D, as doubtfully observed at St. Regis, are rejected.

Name of Station.	Date, Hour, and Minute.	Flashes observed.	Errors of Chronometers on Sidereal Time of Stations.	Sidereal Time of Observation.	Difference of Longitude.
	1844. H. M.	H. M. S.	M. S.	H. M. S. Bro^t. forward.	M. S. 83 23·56
St. Regis . .	July 18, 10 40	18 31 31·2	0 00·30 fast	18 31 30·90	5 13·06
Rouse's Point		18 40 20	3 36·04 „	18 36 43·96	
St. Regis . .	„ „ 10 45	18 36 32·4	0 00·30 „	18 36 32·10	5 12·86
Rouse's Point		18 45 21	3 36·04 „	18 41 44·96	
	Sum of 18 observations . . . . 18)				93 49·48
	Mean difference of longitude by flashes observed on July 19 =				5 12·75

ABSTRACT OF FOREGOING.

				M.	S.
July 14, mean result of corresponding observations of	9	flashes	=	5	13·64
„ 15, „ „	24	„	=	5	13·48
„ 17, „ „	16	„	=	5	13·54
„ 18, „ „	15	„	=	5	12·82
„ 19, „ „	18	„	=	5	12·75
			5)	26	6·23
Astronomical station at St. Regis, west of astronomical station at Rouse's Point				5	13·24

(Signed) JOHN H. PIPON,

Lieutenant, Royal Engineers.

No. 2

NOTICE of the Military Portion of the Works of "Francisco di Giorgio Martini, Architetto Senese," of the 15th Century, published at Turin, 1841, by the "Cavaliere Cesare Saluzzo," &c., &c.

There was published at Turin, in the year 1841, a Treatise on Civil and Military Architecture, which at the time attracted considerable attention, as being a production restored from the 15th century, and the original work of a noted Italian architect and engineer of that age—"Francisco di Giorgio Martini."

For the restoration of this very interesting work we are indebted to the labour of the "Cavaliere Cesare Saluzzo," Lieutenant-General in the service of his Majesty the King of Sardinia, &c. &c., who has caused to be annexed thereto, a sketch of the life of the author, as well as a dissertation and collection of memoranda, illustrating the progress of military architecture in Italy, during the above stated period. This latter portion includes a rapid sketch of the lives and works of those Italians who wrote on Engineering, and on Artillery and Military Machines, from the the year 1285 to 1560—that is to say, from the first commencement of the recovery of ancient military art to the date of what may be termed the second period of modern fortification, which would commence about 1545-74. A list of these honourable names is given in an appendix to the work, and it is remarked in the preface, with becoming pride, that during this age the whole of Europe (Italy excepted) could not produce an equal number of great scientific writers on these subjects.

One of the most distinguished of these is "Francisco di Giorgio Martini," who, born about 1423, is supposed to have died in the year 1506. The limits of this brief notice will not admit of any lengthened account of his life, which is fully detailed in the text. Suffice it here to say, that, in addition to several works of Civil Architecture, he designed several castles and forts in Italy, of which the four following, constructed for the Duke Frederick D'Urbino, are chiefly recognised, viz., the "Rocche di Cagli; di Sassodi Monte Feltro; del Tavoletto; and the Rocca di S. Alondio," besides many others which are attributed to him.

He was also a very skilful artist in bronze, and several of his works in this branch of art are preserved in the cathedral at Sienna, and in other places.

But the object of this paper is to draw attention more particularly to the military portion of his work, viz., Book 5, in which he treats of the Principles of Defence, upon which his works were designed, together with the descriptions of many of them.

Those who peruse his observations upon these subjects, while they admire the simplicity and modesty with which his opinions are exhibited, will acknowledge that the Principles of Defence which govern the construction of detached works were better understood and appreciated in the middle ages than is now usually allowed.

With reference to the long debated question of the origination of the "Bastioned Trace," the compiler of the work in question presents eight separate memoranda; and, after disputing the date of the famous "Bastion Verde" at Turin, claims for

Francesco di Giorgio the merit of having first designed the "bastion trace," although it does not appear that he ever actually constructed it. Without entering into this question, which has already been so often and ably discussed, it will be sufficient for the present purpose to consider some of his earlier designs, in which may be recognised several important portions of the detail of modern fortification; such as "the cuoette in the ditch;" the bastionette and casemated caponière (both attached and detached), couvre-portes, escarp galleries, &c., &c. The invention of the Ravelin, the fausse-bray, and the covered way, are likewise attributed to him, and the drawings of his designs, which accompany the book, certainly exhibit specimens of all these works.

And, as it is an acknowledged military principle at the present day, that the bastioned trace is applicable only where the design is of sufficient magnitude, and there are local means to develope its full dimensions and properties; it is in the smaller and isolated forts, given in this book, that we may find a more interesting study with reference to that class of works which we chiefly adopt in our own defensive systems.

By carefully examining the earlier designs of Francesco di Giorgio, will be perceived, in regular succession, specimens of Defensive Works, which, commencing with the rudest attempts of art, rapidly approximate to the most approved ideas of the present day. Commencing with outlines removed but a few stages from the earlier constructions of straight walls flanked by small towers, he first attempts to gain a greater quantity of defensive fire, by breaking his lines into acute salient and re-entering angles; constructing his towers at the salients, by which he procures some portion of defence for the scarps. Some of these outlines will be found very nearly to approach the "demi-bastion" trace.

We next find the towers at the salients discontinued—the flanks drawn perpendicularly or nearly so to the faces, and the value of an interior keep recognised; and so on, till at length he arrives at an approximation to the "bastioned trace;" resuming, however, his towers at the salients.

At this point he seems to be convinced of the disadvantages of multiplying the angles of defence in small works; for we find in many of the concluding designs a simpler polygonal trace (or nearly so), with interior keep, &c.; and amongst these Tav. 15, Figs. 1 and 2, and more especially Tavola 22, Fig. 1, the two latter of which are drawn to accompany this paper, exhibit some of the most approved details for small forts. See Diagrams 1 and 2.

iagrams 1 and 2.

We have here, in Diagram 2, a simple linear trace, of which the ditch is defended by caponière bastionettes, *covered from the front.* There is a good circular keep, with its ditch, and covered communication to the outer work. The projector's own description of this work should not be here omitted.

iagram .

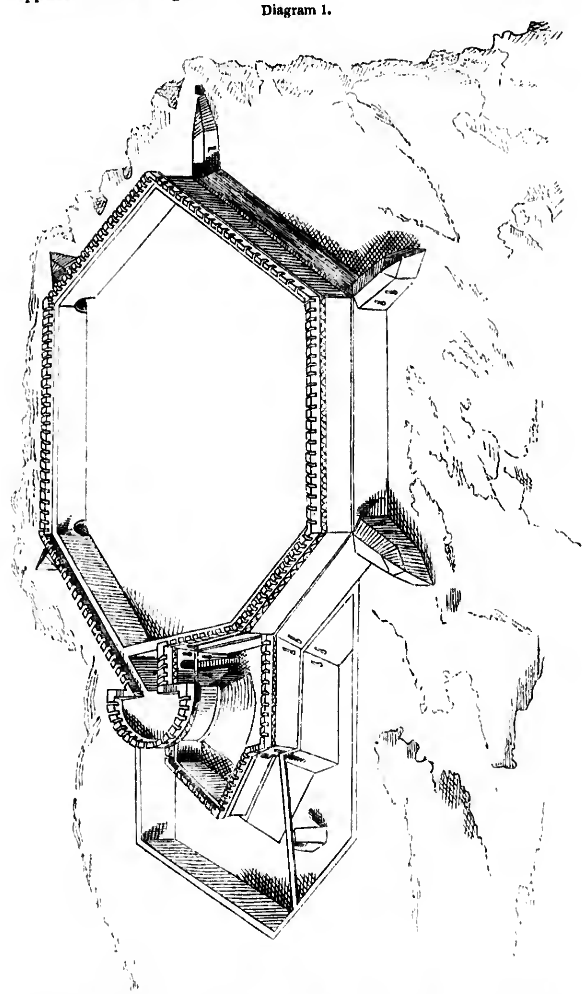
"EXAMPLE 39.—TRACE OF A FORT WITHOUT TOWERS.

"If you would construct a fort without towers (that is at the angles) and strongly, make a polygonal trace, with double walls, counterforts, and the intervals filled with earth, as has been before described. Then construct at the angles, caponières (capannati literally—little cabins or cottages) as before, and above these small pyramidal towers; and before the double wall let there be a ditch with its parts complete; then towards the centre of the work there should be another ditch, and in the midst of that the tower keep with buttresses at its angles. The rooms for the garrison can be constructed in the outer work *, so

* The "Castellano," or Commander, being quartered in the tower, from whence he has command of the entrance of the Fort.

that, after adding other parts already notified, the fort will be impregnable *, as appears from the design."

Diagram 1.

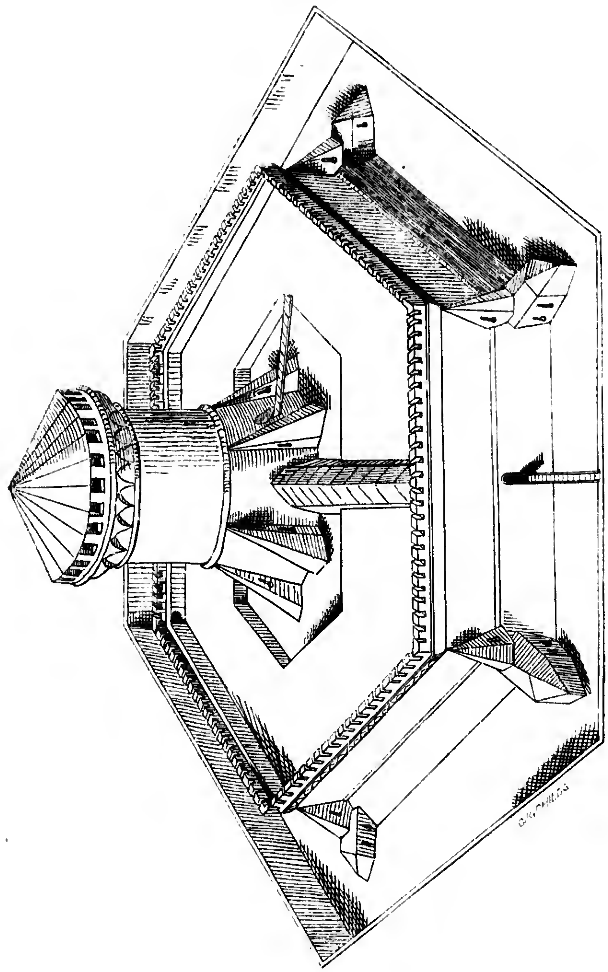


In the opening chapter of his fifth book, the author describes several of the primitive specimens of artillery as used in his day, besides some from his own designs.

* "Inespugnabile."—It must be remembered that this description was written in an age when the art of "Attack" was far less understood than that of Defence.

These latter, independently of their curious construction, display considerable taste and skill in their decoration and ornament.

Diagram 2.



He then proceeds to detail the composition of gunpowder at that time, and the effect of the fire of artillery against walls, &c. The former is curious (Chapter II.) as he recommends different proportions of ingredients for nearly every individual piece of ordnance.

In Chapter IV. he comes to the consideration of the Art of Defence, and in this ter he gives twenty "maxims" for the construction of forts and castles, which, as they give a fair idea of the state of this branch of military art in those days, as well as a curious picture of the times, are here translated literally.

"Being about to treat in this book of the constructions desirable for fortresses —for reasons before stated, we must first consider each part generally, and then descend to particulars.

"Therefore, I say, that all fortresses should possess in themselves:—

"1st. A well or cistern, at least sufficient for drinking, and other necessary operations, situated in the keep or quarters of the 'Castellano;' so that he can distribute it at pleasure, and it cannot be taken from him; and there should be channels by which he can send it to the men's rooms.

"2nd. There should be within the fort a mill and machinery for making gunpowder.

"3rd. An oven to bake bread and other things.

"4th. That there should be secure shelter, so that the fort cannot be taken without some difficulty.

"5th. The principal tower (keep), where is the castellano, shall be stronger and higher than the rest; so that it can command the remainder of the work, without being itself commanded. Thus the Castellano shall have power over the others.

"6th. That if in the same fortress more principal towers, for other 'Castellani,' be constructed, then the keeps and entrances to the work should be so arranged that one castellano cannot, without the consent of the other, admit or send forth any person in the fort.

"7th. That the fort should be of as small circumference as possible, provided its necessary dimensions are preserved.

"8th. That the outer wall shall be *high in itself, but in an unexposed situation* (in basso loco situate), scarped two-thirds of its height, &c.

"9th. That the towers should be attached to the main wall with angular wings, of the same height as the wall, and with their means of offence at the side.

"10th. That in front of the gate there must be constructed a ravelin (rivellino) in some such form as I shall hereafter show.

"11th. That the ditch shall be wide and deep, with a high and extensive glacis (ciglio), arranged so that every one can be seen and destroyed from the fortress.

"12th. That the entrances shall be *indirect* (reversè) and their passages covered.

"13th. That the loop-holes, &c., shall not be distant from each other.

"14th. The quarters of the garrison should be in the outer wall, built in a situation where they can be easily commanded from the keep.

"15th. The circular form for the tower and line of wall has been approved by the ancients; which I confirm as most convenient for the former, because it 'least receives, and best resists,' any shock; but for long walls this is a fault; because, if towers be applied so that one may guard the other, it will be necessary to approach them so near to each other, that the expense will be necessarily much increased. Another inconvenience likewise follows—viz., that the walls cannot be so well guarded by the sentries from the battlements.

And, therefore, having considered what figure is best adapted for the line of wall, I have come to the conclusion, that the rhomb and rhomboid are more perfect than others: so also the quadrangle, octagon, pentagon, hexagon, and other angular figures.

"16th. It should be understood, that the larger the circuit of the fortress, so it requires more angles in its form, but indifferently distributed according to the sito. And this is the 16th condition, 'that the towers should be round and the walls constructed with angles.'

"17th. That the 'salients' should be turned towards those points from whence the fortress is most exposed to the fire of cannon, in order that the *wall* may avoid it.

"18th. The towers should be posted at the angles adjoining the lines, so that each line may be defended by them, as also one tower by the other.

"19th (which is important). That the fort should have convenient outlet, in such manner, that it shall be difficult for an enemy to hinder those within from going out of the fort in security.

"20th. That the walls should be erected on their foundations in the following manner."

There follows in Chapter V. a description of the different methods recommended by the author for establishing foundations in unfavourable sites, &c.; amongst these he clearly describes the use of piles coated with pitch and tallow; also *concrete* ("ghiara e calcino"); and he likewise mentions the use of "reverse arches," and concludes with a proposal for using concrete in cases.

Treating of the proper proportions and defence of the ditch in Chapter VI.

"In the first place it is to be remembered, that the deeper and wider the ditch the better. Their reasonable depth is 40 to 50 feet (including, it is presumed, the height of scarp); and the width, 80 to 100 feet.

"They should in general have a spacious and wide 'glacis' (ciglio), distant somewhat from the ditch, in form (that is in 'section') a scalene triangle, with a direct slope, and the reasons for its distance are two: First, that, if the glacis (crest) approaches at once to the ditch, no small portion of it will fall into the ditch, by which the glacis is lowered and the ditch filled; and the second and principal reason is, that, as the crest of the glacis is advanced from the ditch, it covers so much the greater part of the wall from machines, &c. *

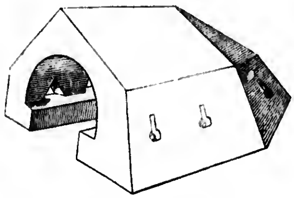
"These simple ditches can be defended in various ways: *of some of which, not to burden my conscience, I shall make no mention*, because, without doubt, they can be arranged with little difficulty, in such manner that a great number of men may be destroyed, unawares, at once.

* This can only be understood, as in the annexed figure;—wherein it will be seen that, when the *height* of the crest of the glacis above the surrounding site remains the same, the farther it is advanced from the scarp, the greater quantity of wall will be covered from a direct shot, such as is here contemplated.

"Some other methods of defence I shall explain which are not so destructive. In the first place construct at the angles of the ditch, 'Capannati' in the form shown in Tavola 5, Figure 1, Diagram 3, which cannot be destroyed by cannon or other machines, and by which, with its loop-holes, the ditch and the scarp can be defended, as will be manifest to any intelligent person."

See diagram No. 3.

Diagram No. 3.



Here we have the Caponière Bastionette, in its complete form, with its advantages recognised.

After describing some other contrivances for the defence of the ditch, which are of less value, he proceeds :—

"5thly. Make in the middle of the bottom of the ditch another ditch, 20 or 25 feet deep, and which should have a width of about 30 feet at bottom, and 25 feet at top (vide section, Fig. 2, Tavola 30), which every man must pass over, since, from its depth, none descending or falling into it can get out again—and for greater perfection arrange the bottom of the main ditch in such manner that no person can stay in that.

See diagram No. 4.

"Make also subterraneous passages from the walls, or from some place within them, through the bottom of this second ditch (*d e e*), by which those within the fort may evacuate it when they please.

"Or 6thly. Make a simple 'fosse' of the aforesaid height and width. Then at the angles throw out a double wall (with embrasures and loop-holes) as large and high on each side as is the scarp; then, at the end of these walls, let the ditch be cut in the form of a semicircle, of such size and diameter that, when a tower is applied to the extremities of the double walls, there remain a ditch about the same tower, of the same size and depth as the remainder. (Tavola 14, Fig. 1.)

See diagram No. 5.

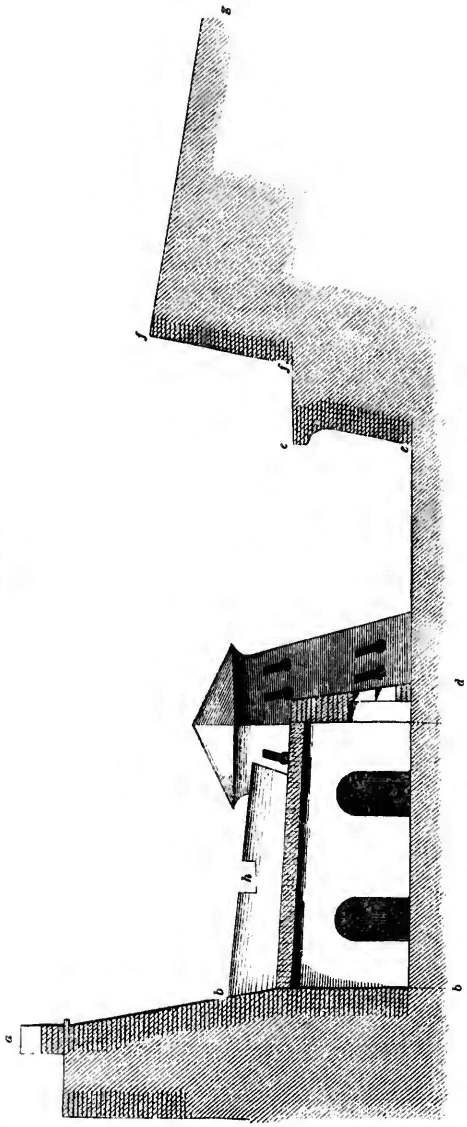
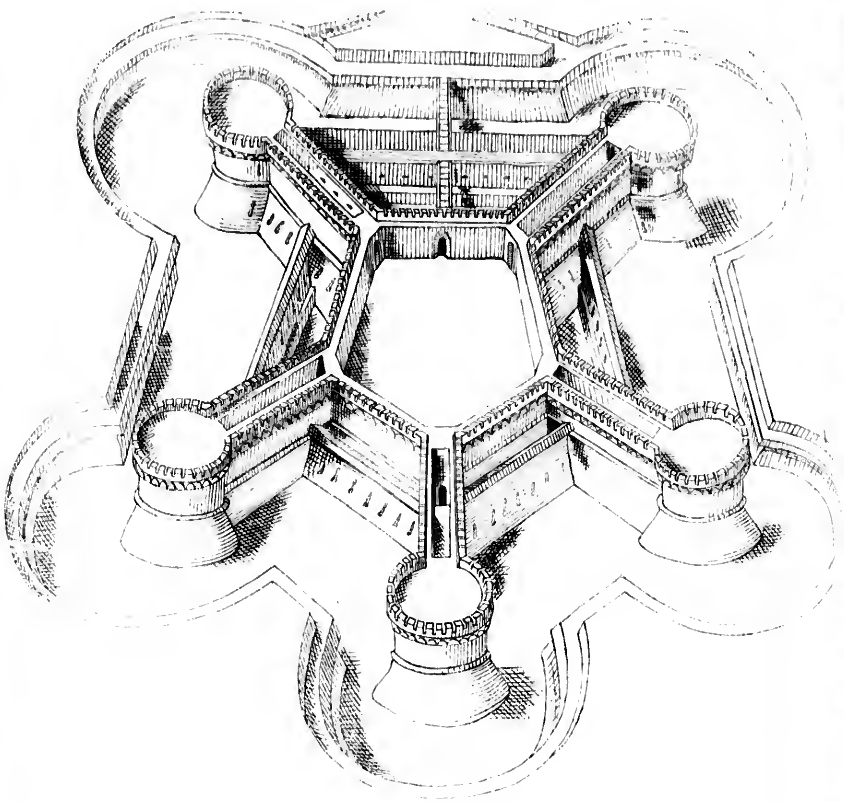


Diagram No. 4.

Diagram 5.



"About the ditch which surrrounds the said towers, construct the glacis and covered way of which I have before spoken, which can be perfectly guarded by the towers; and furthermore, because the said towers can be approached by means of subterraneous galleries without hindrance, construct several 'capannati' between the said towers similarly to those in the ditch; by which the semicircle of the ditch, as well as the towers themselves, can be defended."

See diagrams Nos. 6 and 7.

Introducing his "couvre-portes," or ravelins (rivellini), he says:—

"The 'rivellini' in front of the gates should be placed at a low level, so that they cannot be ruined by artillery; and nevertheless its wall requires a similar

Diagram 6.

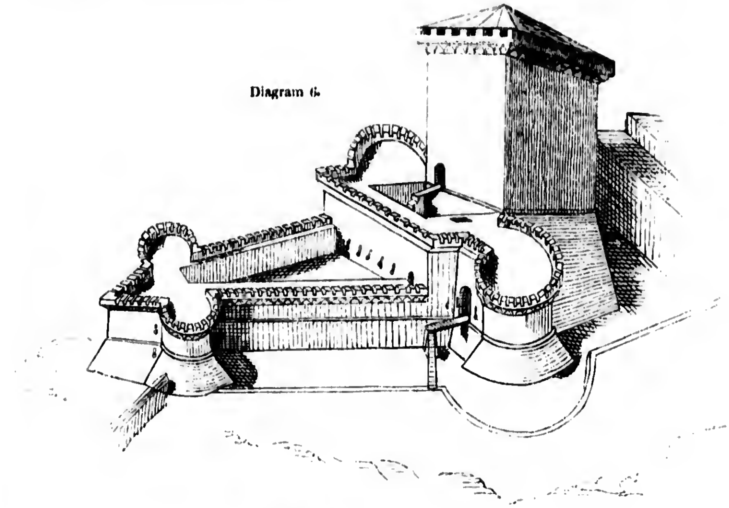
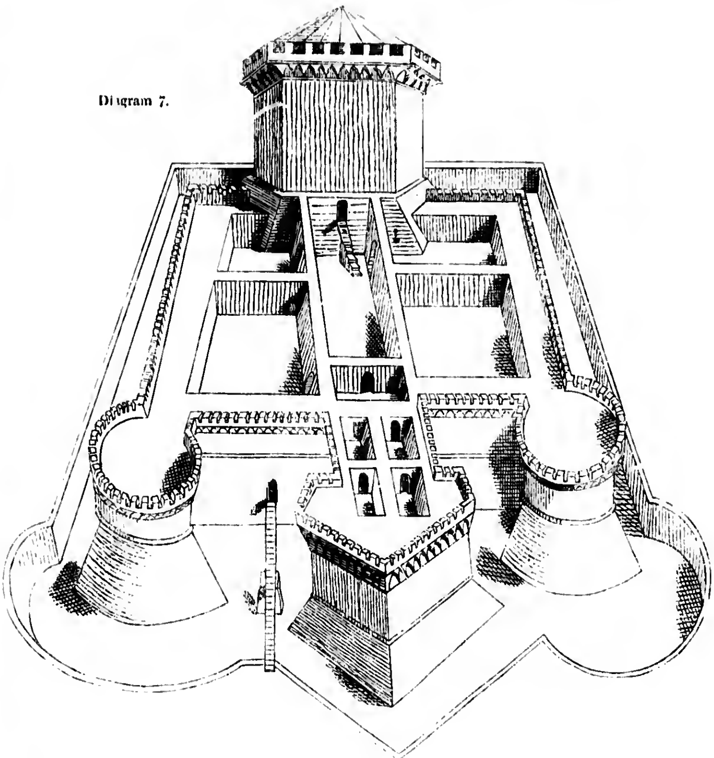


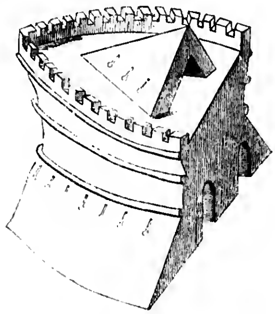
Diagram 7.



height (to that of the main work), or as near it as may be convenient, with a ditch about it, as has been before described.

See diagram 8. "There can be constructed underneath a covered defensive gallery (Tavola

Diagram 8.



5, Fig. 5); and in like manner can be added 'capannati,' according to the judgment of the engineer and the requirements of the site."

See diagram 8. (Figure 5, Tavola 5, shows the escarp gallery here described.)

"CHAPTER VIII.—Towers.

"The diameter of proper defensible towers should be from 50 to 60 feet; entirely solid, with the exception of the defensive galleries in the flanks; and the towers require 50 or 60 feet of height, of *which 30 should be scarped*, and for every 4 or 5 feet of height of scarp should be given 1 of base; preserving the same proportion as the height is more or less. The flank galleries should have chimneys or flues leading out of them, so that those who serve them shall not be impeded by smoke."

After describing the projections, &c., on the upper wall and battlements, he suggests several ingenious contrivances for protection from escalade.

"Likewise, where there are traitors or sleeping sentinels, forts are often taken by 'scaling,' especially those which could not be otherwise reduced. It is necessary to provide against this danger."

See diagrams 9, 10, and 11. With this object, he first proposes the projecting galleries with "machicoulis" and buttresses, below shown in Tavola 6, Figs. 9, 10, 11. Then an enlarged cordon,
See diagram 11. midway up the scarp, of triangular section, so as to prevent ladders approaching the wall, and also affording no footing (Fig. 10), and lastly, he proposes *studding* the upper part of the face of the tower with stones dressed to a triangular shape, and "as hard as adamant," one foot apart, with a cordon beneath; the triangular stones being set
See diagram 9. alternately over and under, as appears in the drawing (Fig. 9).

Diagram 9.

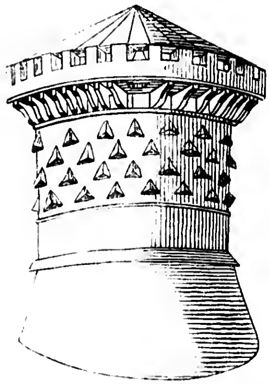


Diagram 10.

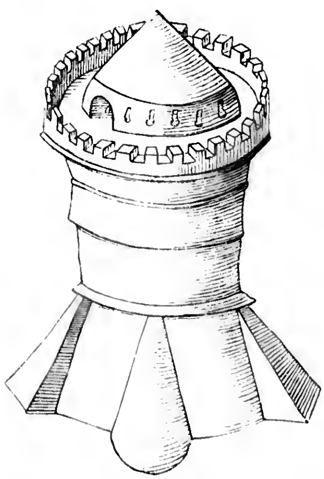
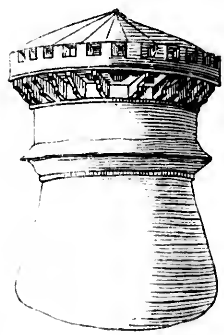


Diagram 11.



"CHAPTER IX.—Of Capannati and Ancient Casemates.

"On the top of the towers, as at their base, can be constructed a covered defensive circular pyramid, with its entrance opening towards the principal tower. In place of the pyramid can be used a building in the shape of a small cottage, or semicircular.

"At the foot of the towers, for the better defence of the walls, can be placed other small covered buildings, of such form as shall best agree with the architecture; and in such a position that they cannot be touched by cannon, otherwise they will render the tower weaker.

"For by means of these 'capannati' greater resistance can be made to an enemy than when fighting hand to hand.

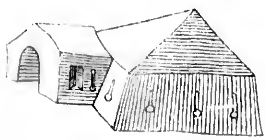
"And because it is not possible in every place to construct wide and deep ditches, with thick towers and walls; and, even where possible, there are not always pecuniary means, or time; I have invented a 'shot-proof' of small expense, time, and material, which work, being in form of a small cottage, I shall call 'Capannato:'—to construct which, at the bottom of the ditch, where is shelter from the fire of cannon, let there be a 'room,' with loopholed walls, 5 or 6 feet thick, the width of which in the clear should be 12 or 14 feet, and the height 8 feet, 'with flues above the embrasures,' and loopholes, so that the musketeers and artillery-men, standing shoulder to shoulder, can use their arms without impediment.

"They can be arranged in various forms, as will appear from the designs."

See diagrams 3, 12, and 13.

Here follow 5 specimens of caponières; of which 3 are given with this paper, viz. Tavola 5, Fig. 1, and Tavola 6, Figs. 1 and 6.

Diagram 12.

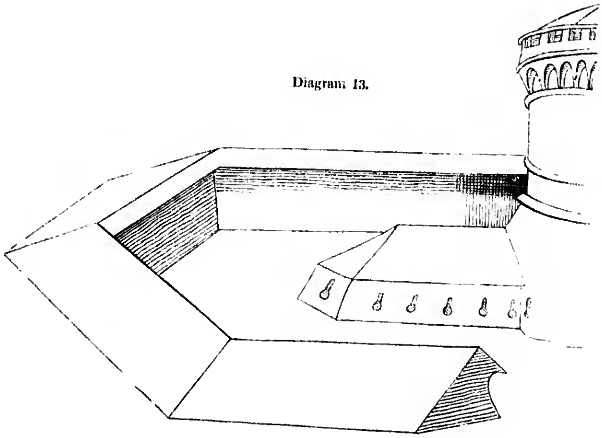


"It is necessary to be careful of two things:—1st. That the 'capannato' should be contiguous or attached to the wall of the fortress, with a narrow-covered entrance from the interior of the work, arranged so that, when the 'capannato' shall be lost, the fortress shall not be taken also; and, to this effect, the covered passage should have doors and other defensive means; or it should be so narrow that it cannot be forced, when defended; or there should be a 'well entrance,' with a moveable ladder, or by means of a drawbridge, or by barriers, or by a portcullis, or other means for expediting the passage of the garrison, and hindering that of the enemy.

"But on the other side of the ditch the said 'capannato' should be separated (from the counter-scarp), or discontinued, leaving at least 8 feet, so that it cannot be injured by subterraneous galleries (through the counterscarp).

"The second thing necessary to remember is, that there should be constructed,

Diagram 13.



in rear of the said 'capannato,' a small and narrow porch, towards the wall of the fortress, with one or two embrasures and loopholes for the guard, as appears in the drawing (Tavola 6, Fig. 1), so that the garrison (but not the enemy) can use them for communication with the ditch or for other purposes.

See diagram 12.

" And this mode of defending walls and ditches, secure against all harm, the more it is considered, the higher it will be valued."

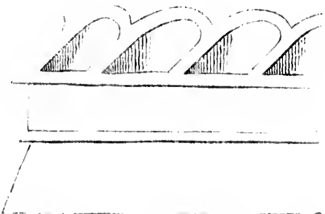
In Chapter X. he recommends a construction for revetments with counterforts for a wall (or parapet), 18 to 20 feet thick; which will be best understood by the drawing (Tavola 6, Fig. 5.)

See diagram 14.

The immediate defence of the entrance to the fort or castle was always a great consideration with the engineers of ancient times; and an examination of the gateways and chambers, &c., adjoining, in any of the old castles in England and Germany, will generally afford evidence of this.

It is singular to observe that, after fixing the drawbridge, and a few other precau-

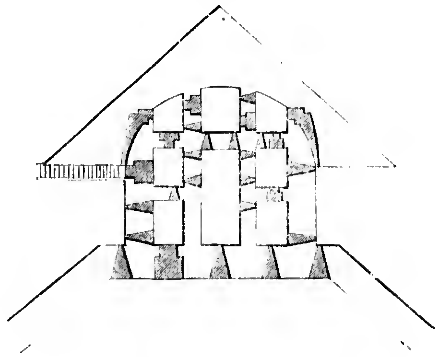
Diagram 14.



tions, little attention was paid to the defence of the gateway, externally; but the detail and intricacy of plan *internally*, and contrivances for disputing the passage, additionally to the common "portcullis," are highly ingenious and curious. Tavcla 7, Figs. 8, 9, 10 (the first of which, Fig. 8, is given with this paper) are illustrations of this species of defence; and it is amusing to follow the "thread" of entrance in

See diagram 15.

Diagram 15.



these designs, and observe the risk to be run by the party assaulting, before he can arrive at any satisfactory footing in the interior of the work.

Speaking of the gateways or entrances into forts; after specifying the most necessary and common precautions, the author recommends that they should *never* be constructed without a "couvre-port," or ravelin, to cover them. That no two entrances should be opposite each other. That the main entrance should have its flank and not its face turned towards the country; and that they should have as much flank defence as possible.

CHAPTER XI.—Of Drawbridges, etc.

He here describes several species of drawbridges which he recommends for adoption.—1st. The horizontal rolling bridge, worked with a capstan and cog-wheel. Then the common drawbridge raised with chains (omitting, however, except in one instance, the counterpoise, which does not elsewhere appear, either in drawings or description). Also a rising bridge with its machinery below, and secure from all injury from without.

The "main tower," or keep, is the subject of the 12th and last chapter in this book (5th). He commences by, as usual, taking good care of the Castellano and the provisions.

> "First, it is to be remembered that the 'Castellano' must be able, alone, to expel the remainder of his party—to have command of the provisions, rooms, quarters, &c., and to possess secret means of assistance, which cannot be intercepted by those within the work. And, to this end, the entrances, &c., to the keep should be arranged in such manner, that when the 'Castellano' has placed in the tower any number of men they shall be as his prisoners, and at his will he can control them."

He then describes the accommodation of the keep, placing the stores in the lower rooms, and the quarters of the Castellano above. The magazine for powder being on the top of all.

> "In the centre of the summit of the tower, let there be a room with two walls, distant apart 2½ feet, where the powder can be placed:—with two doors, not opposite to each other, so that fire may not easily find entrance; and also if by accident fire should reach the powder, it being at the summit, the walls of the tower shall not be ruined.
>
> "In addition, there should be made a circular stair, extending from the base to the summit of the tower, the entrance of which shall be near the quarter of the 'Castellano,' and into this shall open all the other rooms and stores. Near this also should be the well or tank (with narrow mouth, so as not to weaken the wall), and with channels (pipes) leading to the rooms of the consumers, so that it can be supplied or withheld at pleasure: thus it will appear that the 'Castellano,' with those that he can trust, shall be alone masters of the fort.
>
> "The *necessaries* may be placed in a position least open to annoyance from without." *

Having concluded this portion of the 5th book, then follow sixty examples of forts, &c., with drawings accompanying them, and which have already been noticed in this paper, the extent of which will not admit of describing them in detail.

Many of them are stated by him as having been actually constructed, and, amongst the rest, the four mentioned in the commencement—the drawings of which are worthy of attention; but as these designs do not present any remarkable additional details to those already noted, it has not been considered expedient to give the descriptions of them at length.

The writer of this notice trusts, however, that sufficient matter has been extracted from the text to induce a perusal of the work by some of his brother officers who may have the means and opportunity of doing so—more especially as the memorandum, &c., contained in the second volume, will furnish materials for a valuable and interesting addition to the Corps Papers.

RICHARD TYLDEN.
Captain Royal Engineers.

* This is an important point often overlooked in the construction of Forts. In very many the privies are placed in the outer scarps, and in the most exposed situations. Instances are not wanting of places having capitulated partly from this defect. At the capture of Martinique, the fire from the batteries manned by the English sailors destroyed the privies of the garrison, and prevented all communication with them. The annoyance and confusion arising from this was one of the reasons for the capitulation.

No. 3.

MEMORANDA on Mines fired in the Phœnix Park, near Dublin, in 1843–4. By Captain Larcom, Royal Engineers.

In the course of the various works in progress for the improvement of the Phœnix Park, near Dublin, under the direction of Mr. Decimus Burton, for the Commissioners of Woods and Forests, it was thought desirable to remove a huge unsightly cliff, or bank of earth and rock, which bounded a part of its circuit where it overhangs the Liffey.

Mr. Burton was anxious to effect this by gunpowder, not only as likely to be much cheaper than by hand, but because the ground would present a more rugged and less formal aspect.

The bank was about 1000 feet long, and consisted of a substratum of limestone rock, in some places bare to the height of 40 feet, surmounted with earth varying from 35 to 50 feet. The earth was a peculiarly tenacious gravelly clay, indurated by the percolation of water charged with much lime and some iron. It stood absolutely perpendicular.

By permission of the Master-General I undertook the operation, at the request of Mr. Burton, and was allowed the use of the voltaic apparatus existing at the Ordnance Survey Office.

The following is a diary of the several operations.

1843. 8th December (1st Day).

Three mines were fired simultaneously. One at 20 feet line of least resistance; the other two at 25 feet least resistance. The first sunk to 38 feet (A on Plan, Plate 1); the two last to 40 feet (B and C on Plan, Plate 1). The line of least resistance being towards the face of the cliff.

The charge of the first was 200 lbs.; of the two others, 260 lbs. each.

The earth was extremely tenacious. The face of the cliff was perpendicular; and the shafts were sunk without casing. They remained without so much as a stone falling in for a month after they were sunk, but they were kept covered at the top. The powder was in the usual cubical boxes, and placed in chambers, leaving about a foot of air around them. The boxes rested on the solid rock.

My original intention was to have used one lined crater, $\frac{1}{30}$ L L R^3, ranged along the bottom of the earth bank, to blow out its base, trusting that all above would fall.

It was so important, however, to respect the wall and road, that I diminished the charges, in one mine, from 266 lbs. to 200 lbs.—that is, from $\frac{1}{30}$ to $\frac{1}{40}$; in the other two, from 520 lbs. to 260 lbs.—that is, from $\frac{1}{30}$ to $\frac{1}{60}$.

The 200 lbs., at 20 feet, that is, the $\frac{1}{40}$ L L R^3, blew out too rapidly, and the earth proved so tenacious, that it did little more than sink into the cavity, the face being brought back only half way to the shaft. It is obvious that the weight of the earth was not sufficient to overcome its tenacity, and that it required to be thrown forward by the force of powder. This mine, therefore, was too deep for its distance from the face of the cliff.

The 260 lbs. mines—$\frac{1}{60}$ L L R^3—being thrown back 5 feet further, had a resistance to the front nearly double the former ($20^3 = 8000$. $25^3 = 15625$), while their resistance upwards was nearly the same. They therefore produced a greater concussion, but did not blow out so rapidly, and a larger quantity accordingly was shaken down, while the fissures, extending so much further back (25 feet from the shaft, while the other was but 10 feet), gave proof how forcibly the powder had acted upwards in loosening the ground. These fissures being 25 feet back, and 25 feet being the distance of the charge from the front, made it probable that they were in fact a series of concentric shells, and the portions which fell over were parts of these shells. It was remarked, that in the new face of the cliff these curves were all overhanging, while the top had sunk generally. They were sustained by their tenacity, and by the base not having been sufficiently blown out.

These mines, therefore, were undercharged, in fact, nearly "smothered," but the proportion between the front and vertical lines was tolerably good.

All three of these mines, however, were so far satisfactory, as that no rubbish was thrown to any distance which could do damage—not more than 40 feet from the face of the cliff—nor did the rents extend far enough to injure the road behind in the smallest degree.

Being fired simultaneously, and the charges being on the rock, the concussion was felt to a considerable distance; and it was remarked by many persons who stood below the cliff, and but little above the rock, that they felt two shocks, of which doubtless one was conveyed by the undulations of the rock itself, and the other by those propagated less rapidly through the earth *. This we at first supposed was from the firing not being simultaneous, and that only two of the three mines had exploded. We found, however, afterwards, that the whole three had fired, and of the simultaneity the extent of the concussion is the best proof †.

As the rock has never since been laid bare, we have no means of knowing the effect produced upon it by the explosion; but at about 45 feet distance, where it remained visible, it was so cracked in the direction of its cleavage, that the men quarried double the quantity for some time afterwards.

Second Day.

It was resolved to try if firing a mine in the rear of the larger mine simultaneously with it would so assist its effects as to carry back the loosening of the earth to a sufficient extent to enable a terrace of rock to be laid bare, and the earth at the back of it left in a gentle slope.

For this purpose a charge nearly equal to a one-lined crater, at 24 feet from the front and 30 feet deep, viz. 450 lbs., was placed at D (Plate I), and a charge of 180 lbs. placed at F, 24 feet further back, and 19 feet from the surface.

It was afterwards resolved that one barrel, 90 lbs., should be taken out of the larger charge, and placed in a separate chamber E, at 14 feet from the top, the distance at which it ought to produce a one-lined crater.

* It will probably be familiar to many readers, that the different rates of rapidity with which waves of undulation travel through different media have been recently applied with great ingenuity and ability to an Elucidation of the Theory of Earthquakes, by the able and accomplished President of the Geological Society of Dublin, Mr. R. Mallet. (See Transactions of the Royal Irish Academy, Vol. 21.)

Note.—The wave theory of earthquakes is a deduction from the theory of Cordier, that the interior of the earth is still a liquid mass, which is thrown into undulations by the pressure upon it of the solidifying, and therefore contracting, crust, giving rise to earthquakes and volcanic eruptions. Professor Rogers, one of the United States' geologists, has greatly extended the dynamical theory of earthquakes, and the first publication of his views is dated 1843.—Editor's.

† I may be excused for mentioning another and very curious fact, however; viz., that the Rev. Dr. Robinson, the distinguished astronomer of Armagh, who was among the spectators, perceived a distinct interval between the firing of the experimental cartridges, which he estimated at one-twentieth of a second. This appeared to show non-simultaneity, till it was remembered that he stood on the flank, and that the mines were therefore successively about 45 feet further from his ear,—which, at the velocity with which sound travels, exactly accounts for the interval.

The delicate ear of the astronomer alone detected these minute intervals; and, till the cause occurred to us, we feared something had gone wrong.

The sections before and after the explosion show the quantity thrown down, and, as far as could be ascertained, the extent and form of the earth shattered, the whole of which, indeed, appeared completely pulverised (Plate 2, *a b c*). This earth, however, has not been all removed, so that it must continue uncertain. The larger charge, 360 lbs., blew violently to the front, as mine A had done on the first day.

These mines would have shaken down much of the earth loosened by the explosion on the 8th of December, but for a buttress of earth which intervened and deflected the shock.

On this day, also, two mines were fired, shown at G H on the plan (Plate I)—one of them at 18 feet, the other at 20 feet line of least resistance.

The former was encumbered with rubbish in its front, and the latter had, in part of its resistance, the ground shaken by the first day's explosion.

Their charges were 225 lbs. each, nearly what was necessary for one-lined craters. The fissures are shown on the plan (Plate I); they extended 25 feet backwards, and the whole of the earth within that distance was completely shattered.

These mines ought to have produced a greater direct action, but their line of least resistance was in both cases so encumbered, that it can hardly be fairly estimated as an experiment. The whole body of earth was observed to rise about 3 feet, and sink down again. No smoke whatever escaped from any of the mines.

Third Day.

A considerable area had to be taken down on the flank of the quarry; and as the cliff was lower, and the position secured us against all danger to the road or wall, we resolved to use comparatively larger charges in the two Mines I and K, fired on this day.

In one (I) was placed 180 lbs., at 12 feet from the face of the bank, and 15 feet deep. In the other (K) 90 lbs., at 10 feet from each of two faces, and 12 feet deep, being about the charges for two-lined craters, and in both the demolition was much more complete, as well as more violent. The earth, also, was broken into larger fragments, and the result more wild, and suitable to the form required for ornamental planting, showing the advantage of large charges if the space had permitted their use.

By one of them—the smaller—the root of a large elm tree, weighing about one ton, was thrown 30 feet from its position; and, by their joint action, the rubbish in considerable masses was thrown to the same distance.

There was much smoke and considerable noise, but no concussion of the earth was felt.

In one of these mines—the larger—the chamber was filled, leaving no air. The effect was remarkable. Though the charge was less in proportion to its surrounding earth than in the other mine, the effect appeared to be greater, as the whole chamber was laid bare, and the fragments of the box carried out; whereas, in the other, the chamber remained buried, and no part of the box was found. A curious effect of pressure may be noticed. The boxes were wrapped in old canvass, as they had some distance to be carried in a cart from the barracks to the mines, and, though made of seasoned elm, the canvass had impressed its fibre as completely in the wood as if it had been on clay.

It was now thought desirable to finish off the space on which we had operated, that it might be given over to the authorities of the park for planting, and a party was accordingly employed to thrown down the suspended masses, and to loosen and heave over those whose removal was necessary.

The general appearance, at this period of the operation, is shown in Plate 3.

Fourth Day. 16th March, 1844.

The whole of the remainder of the cliff was the subject of this day's operation.

Experience had now shown that, when the charge was even $\frac{1}{40}$th of the cube of the line of least resistance, the effect was somewhat violent, as in mines A, D, and F, and that $\frac{1}{60}$th, as in mines B and C, produced effects more suitable to our present purpose than any of the other proportions we had tried.

That proportion was accordingly adopted for four mines, L, M, N, O (Plate 1), at 45 feet asunder, and 35 feet distant, both from the face of the cliff and the surface of the ground.

After passing the point O, the cliff approached the wall so closely, that in the three next mines, P, Q, R, also at 45 feet asunder, and 35 feet deep, the charges were reduced to $\frac{1}{80}$. (At P the wall was but 70 feet, and at Q and R only 40 feet from the cliff, which rose to 60 feet above it.)

P was charged with 540 lbs., at 35 feet L L R; Q and R with 270 lbs. each, at 28 feet L L R: finally, two small mines, S and T, of 90 lbs. each, with lines of 12 feet, at a depth of 16 feet, completed the occupation of the bank.

Thus, the first seven mines were at the same distance asunder, and at the same depth. The four first, L, M, N, O, it was hoped, would remove the earth, and allow the rock below to be quarried afterwards. In the three next, the depth and distance asunder remained the same; but the distances from the front, and the charges, were diminished, hoping to throw out the bottom only, and allow the upper earth to crumble on its own base.

The effect was satisfactory. The section on *d*, *e*, *f* (Plate 2) shows the whole mass in front of the shafts L, M, N, O, to have been removed, while that on *g*, *h*, *i* shows sinking and crumbling down.

One accident occurred. The quarrymen, anxious to extract stone to the last, had removed a portion of earth in front of the mines Q and R at the bottom of the cliff, and the desire to save the stones of a wall on the top of the cliff led the park authorities to take it away, and scoop out the foundations: the result of this, combined with a heavy fall of rain, was, that a slice of earth came down at the last moment, and reduced the effective line of least resistance of those mines to little more than 25 feet—that is, made the charge $\frac{1}{60}$ instead of $\frac{1}{80}$. The effect was to throw a portion of earth against the wall, a small portion of which subsequently gave way under the weight.

The expense of the whole operation was:—

	£	s.	d.
Gunpowder	£228	4	10
Sinking shafts, tamping, loading	71	7	7½
Paling to keep off cattle and people, repairs of apparatus, tools, &c.	22	17	10¾
Watching	3	12	0
	326	2	4¼
Deduct for casks returned to Storekeeper	10	13	0
	£315	9	4¼

The probable quantity of earth removed was about 66,000 cubic yards, which, at the price paid for similar work in other parts of the park, would have cost £1925.

TABLE OF CHARGES.

		Charge Lbs.	L L R. Feet.	L L R. Cube.	Proportion of charge to cube of L L R.	Depth of shaft to centre of charge.	Remarks.
1st Day.	A	200	20	8000	$\frac{1}{40}$	38	40 feet from centre to centre.
	B	260	25	15625	$\frac{1}{60}$	40	45 feet from centre to centre. (B, C)
	C	260	25	15625	$\frac{1}{60}$	40	
2nd Day.	D	360	24	13824	$\frac{1}{40}$	30	Combined mine; D and E, 24 feet from front. (D, E, F)
	E	90	14	2744	$\frac{1}{30}$	14	
	F	180	19	6859	$\frac{1}{40}$	19	F, 48 feet from front.
	G	225	18	5832	$\frac{1}{26}$	25	36 feet from centre to centre; greatly encumbered with rubbish and earth already loose. (G, H)
	H	225	20	8000	$\frac{1}{35}$	25	
3rd Day.	I	180	12	1728	$\frac{1}{10}$	15	Violent action was desired in these. (I, K)
	K	90	10	1000	$\frac{1}{11}$	12	
4th Day.	L	720	35	42875	$\frac{1}{60}$	35	
	M	720	35	42875	$\frac{1}{60}$	35	From L to S all were 45 feet from centre to centre.
	N	720	35	42875	$\frac{1}{60}$	35	
	O	720	35	42875	$\frac{1}{60}$	35	
	P	540	38	42875	$\frac{1}{80}$	35	Getting closer to the wall.
	Q	270	28	21952	$\frac{1}{80}$	35	Originally 28 feet—overhanging the wall, which, when reduced to 25, they threw down in part. (Q, R)
	R	270	28	21952	$\frac{1}{80}$	35	
	S	90	12	1728	$\frac{1}{20}$	16	Overhanging the wall, but encumbered with rubbish in front. (S, T)
	T	90	12	1728	$\frac{1}{20}$	16	

N.B.—It will be observed that the charges were generally made up of the number of *barrels* of 90 lbs. each, which gave the quantity nearest to the required charge, whether a few pounds more or less.

REMARKS.

These charges $\frac{L\,L\,R^3}{40}$, $\frac{L\,L\,R^3}{60}$, $\frac{L\,L\,R^3}{80}$, were the result of our experiments here, and were arrived at by diminishing gradually from those fixed by Major-General Pasley, the lowest of which is $\frac{L\,L\,R^3}{30}$ for a one-lined crater. But it is worthy of notice that the charge of $\frac{1}{60}$ L L R³ is, as nearly as possible, that fixed by Sir John Burgoyne for blasting in rock, because Sir John's experiments having been made with merchant's blasting powder, and the explosions above described, in government powder, which is nearly double the strength, Sir John's charge of $\frac{L\,L\,R^3}{32}$ may fairly be rendered $\frac{L\,L\,R^3}{60}$*.

This proportion of one-half between the relative strength of the merchant's and the government powder is, however, the mean of only eight experiments roughly made for this operation, merely with a view of determining whether there would be any economy in buying merchant's powder instead of using government powder—and it was found there would not be, though it was only half the price. It does not differ very widely from the proportion arrived at in Sir John's paper.

The difference, indeed, in the strength of the different kinds of powder is difficult to test with accuracy. Sir John was good enough to inform me subsequently, that, according to the experiments made for his blasting operations in 1838-9, the government powder appeared to have double the force of the other with an Eprouvette mortar, while with an Eprouvette gun it showed a force barely $\frac{1}{4}$th greater, and, in trials of bursting shells, a force of about $\frac{1}{2}$ more. It is known that the merchant's powder for blasting is glazed with black lead, for greater security under water, or in damp situations, which reduces its strength to nearly $\frac{2}{3}$rds of its own original force—again making it probably about half that of the government powder†.

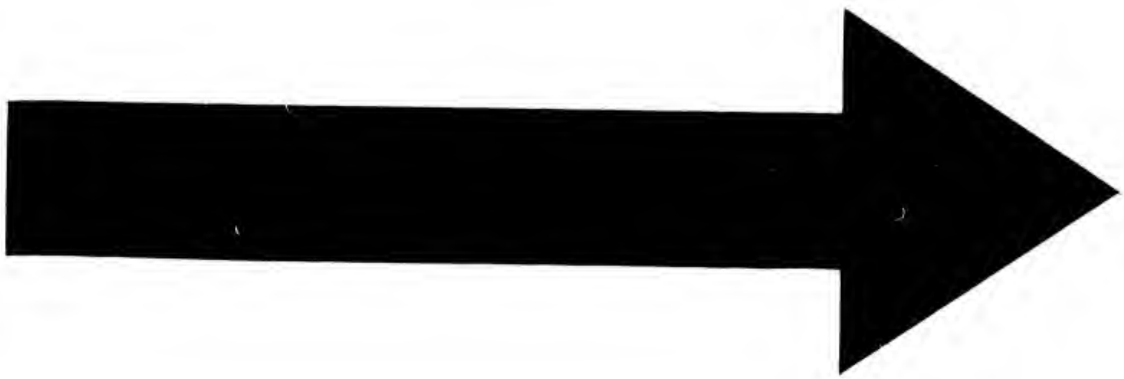
DETAILS OF PREPARING THE CHARGES AND MINES FOR FIRING.

The connecting wires were $\frac{1}{10}$th of an inch diameter (100 feet weighing about 3 lbs.), they were cleaned thoroughly with glass-paper, perfectly lapped with tape, and then immersed in boiling pitch tempered with tallow ‡. Two wires so treated were laid together, lapped with tape, and passed again through the pitch—one labourer

* This appears to have been overlooked in the able operations so admirably conducted and described by Lieut. Hutchinson at Dover, where the charges were computed in Sir John's formula, but fired in government powder. So that they would appear to have been double his charges: in fact, Major-General Pasley's charges for one-lined craters. But at Dover there was no need of keeping down the charges, except to save expense. The base of the cliff might have been thrown to any distance, and the top, from its height, was sure to fall. In the operations above described, the soil was so tenacious, and the height comparatively so small, that it was in some degree necessary to count for removal, on the direct effect of the powder itself, while the space was so confined, that large charges could not be used. These very small charges, $\frac{1}{40}$, $\frac{1}{60}$, and $\frac{1}{80}$, can of course be seldom useful for military demolitions,—nor for any, where there is room to operate. They resulted from the very cramped position within which the effect was to be produced, and the necessity for saving the road and wall.

† A few rocks and masses of earth were afterwards removed by small charges in jumper holes. But, in regard to charges for blasting, with any kind of powder, and the uncertainty which attends them, it might be worthy of investigation, whether the *rupture of crystalline rocks* does not follow a law nearer to the square, than the cube, of the line of least resistance.

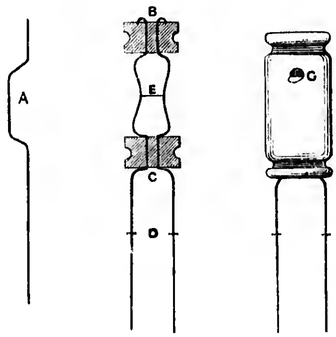
‡ It was intended to have used marine glue, but there was at the time difficulty in procuring it. Gutta Percha, then unknown, would probably be better than either.



and a boy prepared in this way 50 feet per hour. About 6 inches of each end were left uncovered, for the purpose of connecting two or more, when necessary, into convenient lengths.

The cartridges, or igniting charges, were made of cylinders of paper, 1½ inch diameter, and 6 inches long. Two pieces of wood were turned to fit tight to the ends of the cylinder—each 1 inch long, with grooves in their circumference.

The wires, 18 inches long, were bent as at A, and passed through the wood 1 inch apart, bent as at B and C, and secured by hammering down. The centre of the wires between the pieces of wood was pressed together, limiting the space to ⅜ths of an inch, which was found by experiment to be the length * best suited to the power of the battery. The platinum, or igniting wire, was fixed across the centre by



lapping, and soldered to secure perfect contact, as at E. The paper cylinders were then put on, pressed into the grooves on the circumference of the wood, and made fast with wire. A small semicircular aperture, G, was then cut in the side of the cartridge thus formed, through which it was filled with the finest sporting powder, perfectly dried, and the opening closed and secured. It was then tried by the galvanometer, and was ready for inserting into the charges.

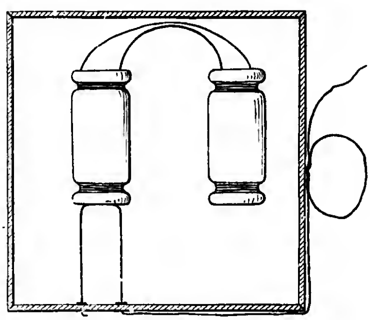
About the centre of the projecting wires two circular disks (flanges) of copper (½ inch diameter) were soldered, D. These were intended to rest on the inner surface of the bottom of the powder-box, to resist any strain, jerk, or drag on the wires in tamping.

The boxes were cubical, constructed in the ordinary way, of the dimensions suited to the charge determined on, rough dovetailed, and pitched in the joints. In the bottom two small holes were made, through which the connecting wires from the cartridges passed out, the flanges above described being pressed upon the bottom. The ends of the connecting wires were then twisted, and soldered to the ends of a length of the double-prepared conducting wires, previously proved, lapped with prepared tape, bent down close to the bottom, secured and covered with pitch.

* This was the result of experiment. It would be very interesting to carry out a series of experiments for the purpose of determining the best conditions, as to relative length and diameter, both of the platina firing wires, and the copper conducting wires. So that, when either of these conditions is fixed by the circumstances under which any particular explosion has to be conducted, the other conditions may be so suited to it as to produce the maximum effect.

The conducting wires were then coiled, and tied to the side of the box, to protect them from injury, as they had to be carried to some distance.

Two cartridges were placed in each box as a precaution in the event of a failure in one, or the fracture of either platinum wire.



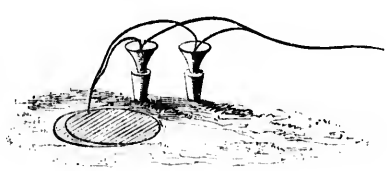
The powder having been put in, the top of the box was secured, pitched over, tightly roped, and covered with canvass. Thus completed, they were ready for carrying to the mine.

As the charges were lowered into the shafts, the conducting wires were uncoiled and secured on the surface of the earth above. Two joists were laid on the bottom, on which the box was slid into the chamber, and on which it rested to keep it from the damp ground.

The conducting wires were pressed into deep grooves cut for their reception in the side of the shaft; they were allowed to hang loosely within the chamber, and springing from under the box were close to the ground, so that they could not be injured if a falling in of the chamber should take place during the tamping, or previous to the explosion.

Before proceeding further, the charges were tested from the surface by the galvanometer; the chambers were then closed with strong boards, and the tamping commenced.

Near the top of each shaft, two pickets 6 inches long were driven into the ground; a roughly constructed tin cup, to be filled with mercury, was screwed into each of these, and into them were plunged the ends of the conducting wires when they reached the surface: this was for the purpose of completing the circuit with the other lengths of double wires which came from the batteries, and saving them from being dragged away with those from the charges, when the explosion took place.



The main conducting wires, 200 feet in length, were uncoiled, reaching from the pickets to the batteries, which were placed at the most convenient position within their range. All the projecting ends of the wires were cleaned with glass-paper, and immersed in a solution of nitrate of mercury before they were placed in the mercury cups.

Batteries.

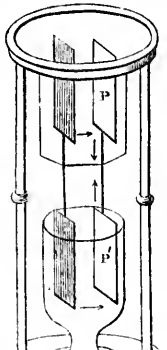
The voltaic apparatus consisted of 24 cells, of Grove's construction, that is, having conducting plates of platinum foil immersed in strong nitric acid, separated from the dilute sulphuric acid in which the zinc is plunged by a diaphragm of porous earthenware; the plates, 6 inches × 3½ inches; also a variety of cells of Daniell's well-known construction, as well as some others which had been in use at the Ordnance Survey Office for the purposes of electrotype. These were used in different combinations, to what seemed to be the best advantage, but doubtless much better could have been devised if prepared on purpose.

The only peculiarity worth describing is an arrangement by which the 3 mines of the first day were fired.

In this, advantage was taken of the principle explained by Professor Daniel, by which opposing currents are generated.

Thus, if two cells be placed one above the other, the two zincs and two platinas being connected together, there will be a current from zinc to platinum in the upper cell, which will pass downwards from P to P, but it is met by a counter-current in the lower cell, from zinc to platinum, ascending from P to P: these currents, being equal, neutralize each other.

On this principle the 24 Grove's cells above described were arranged as three distinct batteries of 8 cells in each series.



The arrangement will be seen in Plate 4, the double wires being separated for the sake of exhibiting the circuit more clearly. The three wires from the negative poles being brought together into a mercury cup (M), and the three from the positive poles uncoated and connected into one, metal in contact with metal, coiled together to the end, where the point of one only forms at last the termination. The fluid might now travel from the negative pole *n* of the battery A, in the direction pointed out by the arrows, through the mine 1, the mercury cup M, and mine 2, till it reaches the battery B; but it is there met by an opposing current (see Fig. 1). In this state there can be no action, until the wire which collects the positive group is plunged into the same mercury cup with the negative wires, when the circuit becomes complete (see Fig. 2).

In like manner the fluid might pass through mine 3, and be neutralized in battery C, or through any number of mines similarly arranged; and it is obvious that in this way any number of batteries may be combined into a single firing wire, and fired by a single contact.

It is necessary, however, that the batteries should be of equal power, and the wires of equal length and diameter, as any considerable excess of power in one battery would be fatal, because the fluid might pass through the weaker battery, the solution becoming the conductor, and thus complete the circuit through the firing wires themselves, independently of a mercury cup; they being, as already said, collected into one, and in actual contact.

On the whole, the operation requires so much delicacy, that, unless the batteries be constructed, charged, and managed with extreme care, it is not to be recommended in hasty operations, nor indeed in any which do not require the most perfect simultaneity, which is seldom the case in military operations, where it is generally sufficient if the interval between the explosions is less than the time which the undulation or disturbance would take to travel from one charge to the next.

The actual operation on the 8th December was thus carried out:—one wire from each of the conductors was connected to a terminal of a battery by a binding screw; the three remaining wires were tied together, and immersed in a mercury cup placed at the batteries. Three wires of convenient length were connected to the three opposite terminals, their ends being previously twisted together; these are denominated the firing wires. The three charges were then tested from the termination of the main conductors, during which time the batteries were in progress of being charged;—this being purposely left to the last, for the sake of the increase of power which would result from the temperature of the water being raised on adding the sulphuric acid—the temperature of the air at the time being very low (about 46°).

On one day, indeed, after a cold and frosty morning, the arrangements having been completed, the wires connected, and the batteries charged, it was inconvenient to delay, and the actual explosion took place during a sudden snow-storm, which greatly increased the effect to the spectators; but the sudden cold weakened the batteries to such an extent, that, if there had not been fortunately an excess of power in them, the operation would probably have failed. The temperature to be desired is about 60°.

To test the efficiency of the batteries previous to firing (although it had been before ascertained that their power was sufficient to overcome much greater resistance), three trial cartridges were placed at the mercury cups—their wires dipping into them, and the wires from the mines turned back. These were tested by the galvanometer, and every precaution taken as if for firing the mines. The firing wires were then dipped into the mercury cup at the batteries to complete the circuit, and the cartridges were found to explode simultaneously. The wires from the mines were then replaced in the mercury cups, the circuit was again completed, and the result was as described in the account of the explosion.

A mechanical mode of firing by one contact was practised on the last day (Fig. 3, Pl. 4), by merely leading the nine mine wires into a general mercury cup, and passing the nine firing wires (in this case coated) through a piece of wood, to keep them from touching each other (the reverse of the former process), and to bring them conveniently within handling grasp, the points projecting about one-eighth of an inch; then plunging these points vertically (and therefore simultaneously) into the mercury cup in which the nine mine wires were already placed. This is less elegant than the other mode, but very convenient, from avoiding any risk.

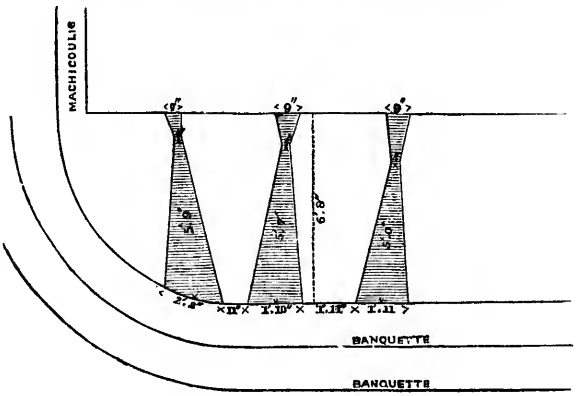
The merit of the voltaic arrangements is due to Mr. Wm. Dalgleish, the ingenious mechanician of the survey; the sinking of the shafts, and the more mechanical operations, were conducted by Corporal Melrose, of the Royal Sappers and Miners.

T. A. L.

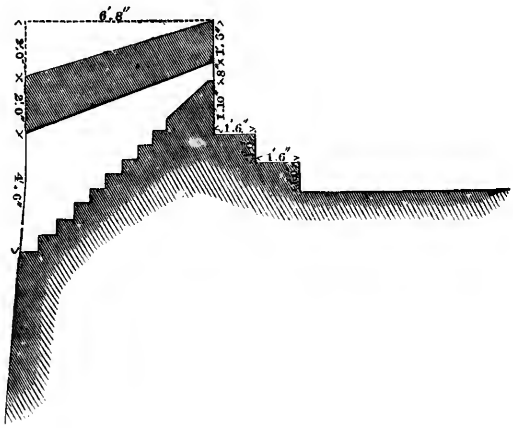
STATEMENT of the effect of the Explosion of Firearms in long narrow Loop-holes, at Aden. By Lieutenant-Colonel C. Waddington, C.B., Bombay Engineers.

The third part of the Aide Mémoire having lately come to hand, I was concerned to find, that the form and dimensions of the Loop-holes, which we have generally adopted at Aden, are in many respects at variance with the rules laid down under the article

PLAN of three of the Loop-holes in Ras Morbut Tower, Aden.



SECTION.



" Loop-hole." Those paragraphs, which most attracted my attention, were the following :—

"The length of barrel of a Musket in our service is about 3 feet 3 inches. As it is necessary that the muzzle should extend 3 inches outside of the loop to prevent inconvenience from the explosion, it is evident that the ordinary form of loop is inapplicable to a wall of a greater thickness than 2 feet 6 inches, or at most 3 feet."

" The interior opening of the loop-hole, for a man to use his musket conveniently, should not be less than 2 feet wide and 1 foot six inches high."

The three loop-holes, of which I inclose a drawing, fulfil neither of the above conditions. The wall is 6 feet 8 inches thick, and no modification of shape in the loop-hole has been adopted to prevent inconvenience from explosion; and, though the interior opening has nearly the width recommended in the Aide Mémoire, its height is only 8 inches.

These loop-holes were, therefore, well adapted for experiment, and I procured the attendance, on the 26th of September, of four Madras Sappers armed with carbines, and of two Europeans with a musket. Lieutenant Smart of the Bombay Engineers was with me.

The Sappers fired each 1 round of blank and 4 rounds of ball cartridge through the loop-holes. The musket was discharged once with blank cartridge, and 6 or 7 times with ball cartridge. Both Lieutenant Smart and myself fired the musket, without being sensible of the slightest inconvenience.

The station for firing through the loop-holes is on the lower or hind banquette. The musket comes to its position in the loop-hole without difficulty, and a deliberate aim is taken in perfect security. We all agreed that the shock of the explosion was no greater than is experienced in firing in the open air. The only injury done to either of the loop-holes was from the first discharge of the musket with blank cartridge, fired into the loop-hole without aim, and probably against one of its sides, which it loosened a little. The smoke cleared off instantaneously after each discharge. The loop-holes are built with sandstone, dressed roughly and set in lime.

It is impossible to provide for every contingency, and local circumstances may render it necessary to deviate from the rules laid down in the Aide Mémoire, as found convenient at Aden.—EDITOR.

SUBSTANCE of a REPORT on a TRAVERSING PLATFORM furnished for the DEFENCES of ADEN. By LIEUT.-COLONEL C. WADDINGTON, C.B., Bombay Engineers.

SOME traversing platforms having been prepared for the defences of Aden, nearly similar to those figured in the Aide Mémoire, Plate 6, Coast Defences, but somewhat higher, it was thought advisable to make a trial of one of them, which was accordingly put into place in the Ras Morbut Battery, commanding the anchorage. The platform traversed on a pivot working in its front transom but not passing through it. The pivot was fixed in a 4-pounder, and that bedded in masonry. Iron racers had been laid for the front and hind trucks of the platform to traverse on. A 68-pounder (8-inch Miller's gun) on the usual garrison-carriage, with truck wheels in front and dumb chocks in rear, was mounted on the platform. The muzzle of the gun was ascertained to be 122 feet above high water mark. Three targets had been previously moored along the deep water channel at a distance from the battery of nearly 900 yards, and at intervals from one another of 360 yards.

On the morning of the 9th September, a party of Europeans of the Madras Artillery was marched down to the battery. The gun was loaded with the service charge, 10 pounds of powder, over which was a hollow shot, weighing 56 lbs., secured with a single wad. At the first discharge, the carriage recoiled to the very end of the platform, striking the chocks there violently. The front of the platform was tilted quite off its pivot. The gun performed a summersault, falling on the rampart with its muzzle to the rear, overhanging the ditch, and the carriage upon it.

As the recoil assigned to this piece (No. 1, in Artillery Table, E, Page 60, Aide Mémoire) is 6½ feet, with a charge of 10 lbs. of powder, there was no apprehension of such a result, and no precautions had been taken against it. On the contrary, the slides had been greased, to facilitate the running up of the carriage; and this greasing, no doubt, assisted the recoil. To remount this heavy gun and carriage on the traversing platform, and get the latter again into its place, was an arduous undertaking, and nothing more could be effected that day.

On the 11th, the practice was resumed; the following precautions being adopted to prevent a recurrence of accident. 1st. The front transom of the traversing platform was lashed down to the pivot gun, a 4-pounder firmly embedded in the masonry. 2nd. A breeching of 4½ inch rope was passed through the perforated button or loop of the 68-pounder, and secured by its two ends to the front eye-bolts of the platform. 3rd. The grease was removed, and the slides of the platform strewed with sand. 4th. The rear chocks of the traversing platform were each covered by a sand-bag, to protect them from the shock of the recoil.

As the unexpected range of the recoil on the 9th (9½ feet) was attributed, in a great measure, to the greasing of the slides, it was desirable to ascertain what difference would arise from their being now covered with sand. Accordingly, the breeching was adjusted so as barely to check the recoil when the carriage approached the end of the slides. The carriage was thus nearly free, and, on the first discharge, it struck the sand-bags with some violence, and tilted up the platform as far as the lashing of its front transom would permit it to rise. After the fifth and seventh discharges respectively, the breeching was shortened; but the platform still tilted, and this continued even after the rope had been shortened a third time, so as to cut off the recoil at 7 feet. The cheek of the breeching rope, when thus farther shortened, reacted on the carriage so as to run it forward again several feet, and the strain bent the eye-bolts to which the rope was attached. The breeching was also greatly stretched, and would not probably have stood for many more rounds.

After the first two rounds from the 68-pounder, its fire was directed in succession at all the three targets. The platform traversed with great facility, and did not require the aid of tackle. Fair practice was made at the targets with an average interval of three minutes between the successive shots. All the shots recochêted and would have been destructive to Shipping. After 14 rounds had been fired, the pivot gun was found to be greatly shaken and the stones in rear of it shattered. The platform had dragged so much to the rear as to slip its hind trucks off the iron racer on which they traversed, and the racer had started one of its screws near the joining of the two pieces which compose it. The firing was then discontinued.

The results of this experiment are instructive, but they rather point out the defects of these traversing platforms than their good qualities. In one most important particular they appear especially faulty, namely, the position of the hind legs, which are so far removed from that end of the platform, that it is tilted at every discharge. This tilting was plainly observable even with the shortest recoil, when, by tightening the breeching, it had been reduced to 7 feet. In this instance, the centre of gravity of the gun and carriage was in front of the hind legs of the platform, which tilted nevertheless as much as the lashings would allow. The platform was not overbalanced, but tilted by the force of the recoil. Let us see how this acts. It is important to distinguish between this action and that of gravity, otherwise we shall not clearly understand what remedies are required.

If we suppose the gun with its carriage to be suspended from a triangle and lowered slowly into position on the hinder extremity of the platform, it might perhaps tilt it up, which would be the simple effect of gravity. If the gun had recoiled to the same position, the tilt would have been more violent, being that due to the combined forces of recoil and of gravity. But, if the recoil be checked whilst the centre of gravity of the gun and carriage are still in front of the hinder legs, the tilting can only be caused by the recoil, the power of which to tilt, be it remarked, depends solely on the height of the gun above the rampart. The direction of the force of recoil is much elevated, being the line of axis of the gun, which, in the late practice, was nearly parallel to the platform, but raised considerably above it, while the platform also stood high above the rampart: and the lever, with which the recoil acts, is the whole height from the loop of the gun to the racer, the former being the recipient of the recoiling force, and the latter the fulcrum of its operation. We know the initial momentum of the recoil to be very great, equal to that of the shot on leaving the gun (as action and reaction are equal and contrary). But this momentum is rapidly exhausted in pushing the heavy gun and carriage, with great friction, up the inclined plane of the platform; and we are surprised to find it still so powerful, after pushing them back seven feet, as to raise the whole mass, platform inclusive, though the centre of gravity of that mass must have been far in front of the fulcrum. This effect is due to the long leverage at which the recoiling force acts, and points out forcibly the disadvantage of increasing the height of the platform.

There is another obvious disadvantage in a high platform, namely the difficulty of securely fixing the pivot on which it traverses. The whole force of recoil is communicated through the platform to the pivot, and acts at its upper end; and, therefore, if the pivot project much above the rampart, the recoil has vast power to shake and drag it in its own direction.

But, though the traversing platforms furnished for Aden are, I imagine, of unusual height, they do not in that respect so greatly exceed the platforms depicted in the Aide Mémoire (Art. Coast Defences, following page 288, Plates 5 and 6) as to account for all the inconveniences experienced in the late practice. The heights of our platform are 4′ in front, and 5′ 4½″ in rear (including the chocks), which heights are 6″ and 8½″, respectively greater than those of the figures above referred to, and nearly the same as of the cast iron platform, in Plate No. 2, described as an authorized pattern. In other respects our platform has the advantage, for its projection beyond the hind legs is only 4′ 2½″, while the projections of those in Plates 5 and 6 are 4′ 6″ and 4′ 5″ respectively, and our slope is also more favourable, being 16½″ in 16′, while the slope in Plates 5 and 6 is 14″ only. An examination of Plate 5 will show that the statement of the slope therein shown as being 1$\frac{1}{16}$″ per foot is erroneous. It is the same as in Plate 6, namely ⅞ of an inch per foot.

Although it is not stated in the Aide Mémoire that the traversing platforms, figured in Plates 5 and 6, have been approved of by Authority, yet I observe that the former is stated to have been "furnished to the circular towers in England," and the Agent for manufacture of Gun Carriages in Bombay stated, that "the platform given in Plate 6, was similar to the muster Barbette platform, sent out by the Honourable Court of Directors in 1846." It further appears from that Agent's letters that the platforms, supplied for the Ras Morbut Battery, were actually constructed according to that muster, though perhaps somewhat increased in height.

It is a fair conclusion from these premises, that a platform, closely resembling the platform furnished for Ras Morbut, has been tried and found to answer; and, as the recoil of the 8-inch gun is stated in the Aide Mémoire to be only 6½ feet, is it not probable that a carriage without trucks, like that figured in Plate 1, and in use also on board the Steamers, may have been used on these trials? On board the Steamers, I find the full charge, for all but great distances, is considered to be 8 lbs.

I think it is an equally just conclusion from the report now made, that the traversing platforms here cannot be used except with some important modifications. The following are some of the changes, which suggest themselves, to remedy their apparent defects.

The platform itself may be lowered, the bed on which it traverses being raised proportionally.

The hind legs may be moved nearer to the end of the platform without too much weakening the cheeks, for the latter have strength sufficient for a longer bearing between the front and hind legs.

The front legs may be cut short, and made to traverse on a circular banquette. This would give stability to the pivot, and also serve as a step.

The front of the platform may, or rather must, be kept from rising. The pivot might pass quite through the front transom, and the latter be keyed down. A Key is shown in Colonel Emmett's dwarf platform (Plate 1, Aide Mémoire). The pivot iron would require also to be secured to its gun by a Key running through both; and the gun must be much longer and heavier than the 4-pounder used in our late practice.

The recoil may be checked by giving a greater slope to the platform. Even with the present carriage, the slope might, I think, be made 20″ to the 16 feet without inconvenience.

Dumb Chocks may be substituted for the front wheels of the carriage, with small trucks in front to facilitate the running up of the gun as in Plate I.

After all, a breeching will probably be found indispensable. Therefore, the front eye-bolts of the platform should be stronger, and the eyes more opened.

The iron racers should be each in one piece and stronger, the iron at least $4'' \times 1''$, to be countersunk in the stone, and the edges not bevelled.

The service charge of the powder may be reduced, but I do not know whether 8lbs. would suffice for the longer ranges.

The masonry of the parapet was somewhat injured by the firing, though not very seriously. It ought, however, to have been constructed of large blocks of sandstone, which construction has lately been adopted for the parapets of the tower.

Figured in Plate I opposite, page 288, Aide Mémoire.

We have one of Colonel Emmet's dwarf traversing platforms here; and I must say, that it appears to me a better proportioned and more serviceable platform than that which we have lately subjected to the test of experiment. I am much inclined to the opinion, that the principal advantage of traversing platforms is to be looked for in the facility of traversing and pointing the gun, rather than in gaining cover by increased height. Whatever the height be, the men employed in spunging, loading, and running up the piece as well as pointing it, must be on the platform, and therefore equally exposed, and much more with a high barbette platform than with a low platform and embrasure.

The traversing platforms, described in Plates 5 and 6, in the Article "Court Defences," in the first volume of the Aide Mémoire, were never intended to carry the heavy guns of 8" calibre; and, at the height of 122 feet, might with safety be placed in battery, *en barbette*, or upon very low traversing platforms on Colonel Emmet's principle."—EDITORS.

ON the Carbonization of Wood by Steam, and on some other important Practical Applications of the Heating Power of Steam. By M. Violette, Commissary in the Powder and Saltpetre Department, and formerly Pupil in the Polytechnic School. Communicated, with Remarks, by Lieut.-Col. Portlock, R.E., F.R.S.

My attention was first drawn to the memoir of M. Violette, as it appeared to me to have a very important bearing on a question much discussed by geologists, namely, the change of bituminous coal into anthracite. I have said change, because the fact is now established, that in geological position, and in accompanying circumstances and fossils, there is no difference between these two varieties of coal; and hence as the development of bitumen in the vegetable relics which constitute coal is considered a result of chemical action under pressure, the anthracitic condition is considered a secondary result from metamorphism. The change has by some been ascribed to the action of igneous rocks, whilst at a high temperature and at no great distance; but by Professor Rogers of Philadelphia, it is explained by the action of steam issuing from the interior of the earth through the cracks consequent on earthquakes and other disturbing movements. The paper of M. Violette shows, that steam heated to a certain temperature, is, at least, an efficient cause for such a change, and is therefore highly interesting in a geological point of view; but it has also great practical merit as regards economical application, and on that account I have extracted it from "Annales de Chimie et de Physique," and now insert it, with some explanatory remarks where necessary, in our corps papers.

In the "Aide Memoire," Vol. 2, Part 1, under the head "Gunpowder," by Major-General Fanshawe, Charcoal is noticed in two paragraphs, page 220, thus: "Charcoal is the woody fibre that remains after the liquid and more volatile parts of the wood have been educted by fire in the process of charring, which process is now usually conducted in iron cylinders instead of in charcoal pits, as formerly, as the charcoal thus produced is found to be less contaminated with foreign mixtures.

"Charcoal is best for gunpowder when newly made from seasoned wood; its goodness is an essential point in the quality of gunpowder; it should be perfectly charred, exhibiting throughout its section the same appearance, either dead black or shining according to the nature of the wood; quite soft and free from extraneous particles." These remarks are generally correct, but they do not sufficiently explain the sources of difference in the ultimate properties of charcoal, and the means therefore of securing a uniform quality. M. Violette enumerates the various modes of manufacturing charcoal. 1st. In heaps in the open air as in woodlands. 2nd. By stifled combustion in small hemispherical vessels, also in the open air; and, 3rdly, by distillation in cast-iron cylinders or retorts, heated by an external furnace, as in the manufacture of vinegar or pyroligneous acid. All these methods are, however, defective in a very essential point, namely, the regulation of the temperature, the experiments of M. Violette having fully proved that the quality of the charcoal depends materially on the temperature at which it is produced—a fact indeed previously known.

When wood is carbonized in close vessels, and great heat is applied, the charcoal produced is very black, being deprived of almost all the volatile hydroginized substances, whilst a more moderate heat produces a reddish charcoal, nearer in character to wood, and still rich in volatile principles. This latter quality is that suited to the manufacture of the finest sporting gunpowder, and the exact temperature at which it is produced was the first object of M. Violette's researches, as the product is still wood at a lower, and at a higher becomes one of the black charcoals. The apparatus he used was (Plate 1, Fig. 1) a large glass tube A, in which was an alloy composed of bismuth 1 part, lead 4 parts, tin 3½ parts, and fusible at 320° Fahr. This tube is suspended to the upper edge of the glass chimney, V, of a Carcel lamp, L, by which the temperature of the metallic bath can be readily regulated, and, by a proper adjustment of the wick, maintained for several hours at a uniform intensity. In the bath is plunged a mercurial thermometer, C, carefully graduated to 662°, a limit which should not be passed, as it is the boiling point of mercury. In the bath three tubes, B, are plunged: they are closed at the lower ends, and into them are introduced the small pieces of wood, *i*, to be carbonized, which can be withdrawn by means of the platinum wires, D, to which they are attached. The wood is thus kept at the required temperature, without a sensible contact with the air.

1st Experiment. Temperature 392°.

The wood, after exposure to this heat for one hour, was *not* converted into charcoal, it was merely browned, and did *not* blacken paper by friction.

2nd Experiment. Temperature 482°.

The wood after an hour has entirely lost its original colour, and acquired that of red charcoal; but it is hard, resisting, tenacious, brittle, scarcely marks paper, and is easily scraped; it is *not* converted into charcoal. After two hours, at the same temperature, it has the colour of red charcoal, is still hard and resisting, though less so than before, and strongly marks paper with a yellowish red streak. It burns with a flame, as did the preceding, but the combustion is not maintained. The surface of the wood is, in fact, converted into good charcoal, whilst the interior continues wood. It is therefore only an imperfect charcoal.

After exposure for three hours to the same temperature, the wood is converted into a red, hard, resisting, brittle charcoal, which strongly marks paper with a yellow red streak. It burns with flame, but the combustion is not continued. In a mortar it separates into woody fibres, which are readily reduced to a reddish powder. This kind of charcoal seems to be an intermediate state between true charcoal and wood; it is neither one nor the other, but, as it is easily pulverized, it may be assumed, that if powder were made of it, it would be of a superior quality. The general result of this experiment, therefore, is, that wood exposed for any length of time to a temperature of 482° is only imperfectly carbonized.

3rd Experiment. Temperature 540°.

After exposure to this heat for an hour, the wood is converted into a very good red charcoal, still tolerably hard, though easily pulverized, and leaving on paper a strong sepia streak. It burns with flame, and the combustion gradually spreads through the fragment of charcoal. 100 milligrammes (1.54 grains) of wood yielded 42 milligrammes (·65 grain) of charcoal.

The wood exposed to the heat for two hours was converted into a good red charcoal, more perfect than the last, as possessing superior qualities. Its yellow streak on paper was more marked, and it was more friable. It burnt with flame and more actively than the preceding. The return of charcoal was in this case 40 per cent.

After three hours, the wood was converted into a still better charcoal. The streak was more marked, and its combustion more vivid. The return of charcoal was 36 per cent.

4th Experiment. Temperature 630°.

Wood exposed to this heat for half an hour was changed into a charcoal, still red, but less so than the products of the preceding experiments, although it possessed the same physical properties. It was tender, friable, and easily pulverized, being in fact, a more perfectly burnt charcoal. The return was 35 per cent.

The wood in all the experiments was Rhamnus *Frangula*, or Alder Buckthorn *, containing 6 per cent. of water, and having been several years in store: and this fact was established, that the lowest temperature at which it is possible to convert wood into the best red charcoal varies between 540° and 630° of Fahrenheit.

At 482° the product is an imperfect charcoal; at 540° the product is a red charcoal; above 630° the product is a black charcoal.

The quantity of charcoal decreases with the increase of temperature, and with the same temperature the quantity decreases with the length of the experiment; though it is probable that, after a certain time, the volatile matters having been entirely expelled, the decomposition would cease, and the amount obtained by carbonization become constant. It is evident, then, that an augmentation of temperature beyond the boiling point of mercury, must be injurious to the quality, and lessen the quantity, of charcoal obtained; and as, by ordinary distillation in cylinders, it is scarcely practicable to limit the heat with precision, some other system appeared desirable.

The first attempt to effect this object by highly heated steam was made by Messrs. Thomas and Laurens, Civil Engineers, in the manufacture of animal black or charcoal, and the success of their experiments induced M. Violette to apply the same agent to the carbonization of wood, as he considered it possible to maintain the temperature within the necessary limits, either by adjustment of the cock by which the vapour was admitted, or by regulating the fire which heats the serpentine through which the steam passes after leaving the generating boiler. The trial apparatus for this purpose is represented in Fig. 5. It was sufficiently large to hold 2 lbs. 3¼ oz. avoirdupois, and therefore a great extension, as to quantities, of the first trials to determine temperature. With the charcoal thus manufactured, were made 175 lbs. of extra fine sporting powder, which on trial with an Eprouvette, was found to be superior to powder made at the same time, and under similar circumstances, with the ordinary charcoal by distillation. The return in charcoal was also greater, amounting to 42 per cent., whereas, by the old process, it rarely rose to 33 per cent., and was generally between 28 and 33 per cent., so that, even in this respect, there would be a considerable saving in an establishment which consumes annually 6625 lbs. of charcoal in the manufacture of sporting powder. The experimental apparatus will be readily understood by an inspection of Figs. 5 and 6: *a* is a copper cylinder pierced with holes to receive the wood for carbonization; *b*, mouth of the cylinder, closed by a screw disc or plate, when the wood has been introduced; c, copper cylinder, surrounding the cylinder *a*, the heated steam circulating between the two cylinders before it enters the inner cylinder *a*; *d*, copper cylinder, surrounding the preceding apparatus so as to prevent refrigeration by contact with the external air; *e*, *e*, moveable lids of the cylinder *d*; *f*,

* In a translation of this memoir which I have seen since I wrote my translation, in the Patent Journal, the name of the wood has been erroneously printed "Blackthorn," which is Prunus *spinosa*, the Sloe.

tube by which the vapour is brought from the steam-boiler at *x*; *g*, small copper serpentine tube through which the steam passes, and is highly heated by the flue of the furnace *l*; *h*, small reservoir, containing a thermometer; *i*, tube by which the vapour, when heated, is conveyed to the cylinder *a*; *j*, tube by which the steam escapes after having traversed the wood; *k k'*, tables for supporting the apparatus; *l*, reverberating furnace.

The success of the experiment induced M. Violette to apply to the Minister of War, through the Director of the Powder Establishments, for authority to erect an apparatus on a larger scale; and on the 2nd July, 1846, a special grant of about £200 was made for the purpose, and after some minor difficulties had been overcome, this apparatus, provided with a serpentine of forged iron, was brought into effective operation on the 16th June, 1847, and has continued ever since to supply charcoal for the powder manufactory of Esquerdes. M. Violette has since been informed that wood had been also carbonized by steam for the manufacture of powder in Belgium.

The apparatus of Esquerdes is represented in Figs. 7, 8, 9, 10, Plate 2. It is composed of two cast-iron cylinders, H and K, of which the inner one, K, receives the wood, and the outer, H, serves as an envelope. The spiral serpentine of iron, C, is placed below, one extremity communicating with a steam-boiler D, and the other with the bottom of the casing cylinder H. A furnace, A, fed with either wood or coke, heats the serpentine to the required temperature. The cylinder, H, is closed by a lid of forged iron, I, and two cast-iron doors, F, close the apparatus, and prevent external refrigeration. A copper tube, L, connected with the bottom of the cylinder, K, permits the steam to escape as well as the volatile products of distillation. The chimney, G, allows the smoke of the fire-place, A, to escape. The whole apparatus is surrounded by a considerable mass of masonry, and is placed in a building contiguous to that which contains a steam-boiler, used for other purposes: B represents the masonry vault over the fire-place and ash-pit; *a*, a small glass window above the vault B, through which the flame and the serpentine can be seen; *b*, a small bridge of masonry, which forces the flame to rise to the upper part of the serpentine. The serpentine, C, is made of forged iron about $\frac{2}{10}$ths of an inch thick, and $\frac{8}{10}$ths of an inch internal diameter: at one of its extremities it is connected by a cock, C, with a copper tube, *d d' d''*, which communicates with the steam-boiler, D, and at the other extremity, *c*, it is connected with the bottom of the cylinder, H: it is kept steady in its place by flat bars of iron, *f*, let into the masonry; E is a hollow cylinder of light cast iron, closed at its ends, and kept in the axis of the serpentine by the iron cramps, *g*, Fig. 9, the object of its introduction being to prevent the direct passage of the flame along the axis of the serpentine, and to force it to act on the whirls of the spiral. The cast-iron cylinder, H, is $\frac{4}{10}$ths of an inch thick; it rests on the masonry at *h*, and is kept firm by two iron partitions, *i*, Fig. 9, fixed into grooves of the masonry, and serving as channels for the hot air from the fire-place, A. The cylinder is closed behind, where the serpentine enters it, and is furnished in front with a cast-iron collar, *l*, to which the closed lid I, is, screwed. The lid I is $\frac{4}{10}$ths of an inch thick; J, horizontal bar of forged iron, fixed at its extremities to the collar, *l*, and serving as a support to the iron screw, *m*, which presses against and keeps firm the lid I. The cylinder K is of cast-iron, $\frac{2}{10}$ths of an inch thick, closed behind and open in front. It is supported by 8 iron cramps, *n*, and is provided with 4 iron bars, *o*, and a circular disc, *p*, by which the amount of immersion of the cylinder K into H may be regulated. L, copper tube, provided with cocks for allowing the steam and products of distillation to escape (*see* Fig. 10, Plate 2). M, a cylinder of cast-iron, pierced with holes, into which the wood is placed: this cylinder is introduced into the cylinder K. The course of the operation in this apparatus, and virtually in the small experimental apparatus previously described, is as follows.

The steam proceeding from the boiler, D, circulates in the serpentine, C, enters by the rear of the cylinder, H, is spread over the lid P, and passes between the two cylinders, H and K, both of which it strongly heats, and then enters K at its anterior end. It now bathes, as it were, the wood, and penetrates into its pores, heating it to such an extent as to induce distillation of its volatile constituents, and then escapes with them by the tube L. The apparatus has now been at work at Esquerdes for more than a year, is still in effective order, and will be so for a considerable time. It has already made 5521 lbs. of good charcoal, and is more than equal to the demand of the two powder mills at Esquerdes, as it could supply charcoal equivalent to the manufacture of 883 lbs. of gunpowder per diem.

The following remarks will serve as a guide to the engineer who wishes to carry this operation into effect, and will enable him to estimate the importance of each step in the process.

It has been shown that a definite temperature is required for the production of a definite quality of charcoal, and this object is attained by the use of steam. The fire having been lighted and the serpentine heated, the cock is opened and the steam admitted, which, acquiring a high temperature in its passage through the serpentine, enters the outer cylinder, H, and after passing between it and K, enters K, and insinuating itself into the pores of the wood, produces the effects above detailed to such an extent that not a trace of tar is left in the cylinder, all being expelled as by a piston. The charcoal is always of superior quality, being black or red according to the temperature and the time of operation, but never covered with a varnish or shining coat of dried pitch, which reduces charcoal to an inferior quality, which is usually reserved for mining powder.

As the quality of the charcoal depends entirely on the temperature, it is necessary to have the means of knowing that it continues constant during the operation; and as a mercurial thermometer could not be used, the boiling point of mercury being too near the temperature required, and an air thermometer was not readily applicable, M. Violette made use of fusible alloys for the purpose, by means of the apparatus shown in Fig. 2, Plate 1: *a* is a small hollow copper tube, closed at one end, and the other entering into the cylinder K; it contains a small cylinder of either tin, lead, or an alloy. A small iron rod or needle, c, rests on the cylinder, and is surmounted by a weight, *d*, which causes the iron rod to sink down when the fusible metal or alloy melts. There are four tubes of this description, which, by a proper choice of alloys, give a range of temperature from 450° to 720°. By the use of the enveloping cylinder, M, it is easy to introduce or withdraw the charge of wood, and as it is made either of metallic wire, or of thin cast iron pierced with holes at about ″·8 to 1″ apart and ″·4 in diameter, by which the flame is prevented from passing outwards, even should the charcoal ignite on its removal from the apparatus.

Tension of the Steam.—This is an important consideration, as the steam must be considered not merely as a vehicle for conveying heat, but also as a mechanical agent to drive away the bituminous substances produced by distillation. If the tension were allowed to be too low, the steam would not be able to expel the tar, and a varnished or inferior charcoal would be the result. This glazed charcoal was by experiment found to be produced whenever the tension of the vapour was so low as ¼ atmosphere above the ordinary pressure: at ½ atmosphere above ordinary pressure a good charcoal was obtained; and at 1 atmosphere above, or a total tension of 2 atmospheres, the working of the apparatus was perfect.

Fuel.—For the furnace which heats the steam-boiler coal was employed, and for heating the serpentine wood was at first used, as it was considered unsafe to allow the sulphureous vapours of coal to come in contact with the iron of the serpentine, but coke has replaced the wood with advantage.

Manipulation.—The charge of wood is from 55 to 66 lbs. In the morning the attendant lights the fire of the steam-boiler, and when the gauge indicates a pressure of one atmosphere, he lights the fire which heats the serpentine; after a quarter of an hour he opens the two doors of the apparatus, introduces the charging cylinder, M, applies the closing lid, the circular edge of which had previously been smeared with a thin layer of clay, turns the fixing screw firmly, and closes both doors. After 10 minutes, when the clay will be tolerably dried, he opens the steam-cock, and the steam rushes into the apparatus. Experience will soon enable him to manage the fire so as to keep up a right and constant action of the flame which he can also watch through the glass aperture *a*. After some time, the metallic thermometer indicates that the tin has fused, and the steam, by its smell and colour, then shows that carbonization has commenced, as it is already mixed with the first products of distillation. The vapour thickens, and successively assumes aspects which are certain guides to the experienced operative, as, by attending to them, he is sure of his results. Two hours after carbonization or distillation has commenced, the smoke indicates that the operation has ceased, and it is important to remove the product immediately, as continued exposure for even 4 minutes would be sufficient to change the red into black charcoal. Two attendants take up the large receiving cylinder of cast-iron, 21″½ in diameter, and about 4′ feet long, and stand ready to receive the charcoal. The chief attendant shuts off the steam, opens the doors, slackens the retaining screw, and seizes with wooden handles which he holds in his hand, the projecting ends of the transverse bar J (Fig. 8, Plate 2) which supports the lid, removes and plunges it into water; he seizes in the same manner, the closing lid of the cylinder, gives it a slight circular movement so as to detach the clay, removes and plunges it also into water. The workmen now hold the receiving cylinder horizontally before the mouth of the exterior cylinder, H, and hold it so as to close the orifice; the chief attendant introduces, by the tube, L, a long iron rod, by which he pushes forward the envelope, M, Fig. 10, Plate 2, which glides on with its charge of charcoal, and is received into the receiver, which the attendants remove immediately, place it on the ground, and having closed it with a lid, and surrounded with water the hydraulic cement with which the receiver is secured, the charging cylinder M (Fig 10, Plate 2) is now replenished, and the operation repeated; but as the apparatus has now been heated, the second charge begins to be carbonized in a quarter of an hour, and the operation is completed in two instead of three hours, and at about the sixth charge, the time is reduced to 1½ hour.

N.B.—The term red is used for the sake of simplicity throughout this translation, although the word "roux" means a tint between yellow and red, such as that of red hair, or rather a ferruginous tint.

The following Table gives the statistics of the operation, both as regards fuel and product. And it must be observed that two qualities of charcoal only are sought, namely, very red, for the finest sporting gunpowder, and black, or less red, for artillery and mining purposes.

Tension of vapour in atmospheres.	Number of successive operations or charges.	Average time of each charge.	Quantities.						Per centage of red charcoal obtained.	Remarks.
			Coal used in heating boiler.	Wood used in heating serpentine.	Wood subjected to carbonization.	Product in Charcoal.				
						Red in lbs.	Black in lbs.	Imperfect lbs.		
		h. m.	lbs.	lbs.	lbs.					
2	4	2 18	265	192	221	76¼	...	7	34·5	The steam boiler was kept heated for 13 hours without interruption, that is, from 6 in the morning till 7 in the evening, and the coal stated to have been used was that consumed during that period. The serpentine was at first heated by wood, but after February, 1848, coke has been used, and the proportion of 11 to 13 lbs. for each charge.
...	4	2 25	265	225	221	82½	...	$\frac{1}{25}$	37·4	
...	5	2 23	269	212	276¼	95	...	3	34·4	
...	4	2 19	256	144	221	76	...	2½	34·2	
...	4	2 2	260	176	221	77½	...	9½	35·1	
...	4	2 20	276	192	221	75¼	...	10¼	34·1	
...	3	2 18	252	159	166	59	...	3¼	35·6	
...	3	2 10	254	150	166	57	...	1¼	34·5	
1	5	1 53	269	234	276¼	89¼	...	...	32·3	
...	4	1 51	256	196	221	74½	...	...	33·8	
...	5	2 18	260	161	309	113½	...	...	36·8	
...	5	2 21	254	157	287	105	...	...	36·6	
...	5	2 20	188	179	320	114¼	...	3½	35·7	
...	4	2 22	181	126	265	98	...	$\frac{9}{10}$	37·0	

In the experiments thus detailed, the red charcoal obtained was of a fine quality, and admirably fitted for the manufacture of the best sporting powder. In the buckthorn used for carbonization, the proportion of moisture was from 10 to 12 per cent., and the general mean of the results may be thus stated per cent.

Red Charcoal.	Black Charcoal.	Imperfect Charcoal.
36·50	0·0	1·66

And if the moisture were deducted from the gross weight of wood, the return would be 40·20 per cent. As the object was to obtain the red charcoal, M. Violette preferred the production of a little imperfect charcoal to that of black charcoal, which might at any time be obtained by a slight augmentation of temperature, or by protracting the operation a little longer. The imperfect charcoal being again subjected to the process makes excellent charcoal.

The wood which has been left during the night in the apparatus, still continuing heated from preceding operations, becomes so dry as to be carbonized very quickly in the next morning, and therefore with a great saving of fuel. In the Esquerdes establishment, six charges were carbonized each day. The daily consumption of coal varies between 177 lbs. and 265 lbs., and for 221 lbs. of charcoal produced, the consumption of wood for heating the serpentine, varies from 331 to 442 lbs., or of coke from 126 lbs. to 177 lbs., that is, 175 lbs. of coal or 67 lbs. of coke for each 100 lbs. of charcoal; but these quantities will be much diminished by the use of the improved apparatus to be afterwards described.

To compare the relative products of this mode of carbonization, and of the old mode by distillation in cylinders, the following Table may be used in reference to the preceding, as it exhibits the results for four years at Esquerdes.

Quantity of Charcoal produced at the Powder Establishment of Esquerdes during Four Years, in the ordinary mode by distillation in cylinders.

Years.	Wood consumed in heating the cylinders in lbs.	Buckthorn wood submitted to distillation.	Charcoal obtained.					
			Red.		Black.		Total.	
			Quantity in lbs.	Per centage.	Quantity in lbs.	Per centage.	Quantity in lbs.	Per centage.
1843	14612	22394	2864	12·8	4507	20·1	7871	32·9
1844	9606	13904	2279	13·4	2071	14·9	4350	31·3
1845	5373	7095	1097	15·5	1131	16·0	2228	31·5
1846	7287	7773	938	12·1	1575	20·3	2513	32·3
	17200	23171	3251	14·1	4204	17·8	7455	32·0

Hence it appears that the per centage in black and red charcoals was only 32, whereas in the steam-carbonizing apparatus it amounted to 36·5 of red charcoal.

In regard to the expense of production it may be admitted that the manual labour in both processes is the same, and it is therefore only necessary to examine the relative cost of fuel which is exhibited in the following Table, which takes also into account both modes of heating the serpentine, namely, by wood and by coke; the quantity of charcoal produced being 221 lbs. or 100 killogrammes.

Nature of Process.	Coal for Steam Boiler.	Wood for Serpentine.	Coke for Serpentine.	Cost of Fuel.
	lbs.	lbs.	lbs.	*s.* *d.*
Old process by distillation .	...	.	...	12 6
New process (wood used) .	353	331	...	10 0
New process (coke used) .	353	...	267	7 5

But the price of fuel in England, using coal and coke, will be less than half the above, so that it may be assumed that the cost in fuel of producing 112 lbs. of charcoal will be 1*s.* 10½*d.*, the coal being valued at 16*s.* per ton; and as it may be procured for such purposes at about 12*s.* per ton, the cost may be taken at 1*s.* 5*d.* per cwt. of red charcoal.

M. Violette further describes the modifications which he proposes for a more extended apparatus and manufacture (*see* Fig. 3, Plate 1). Instead of a single cylinder he adopts two, A and B, Fig. 3, placed within a masonry vault; these cylinders are in length the same as those of the preceding apparatus, but the space between the outer and inner cylinders, H and K, Plate 1 (Fig. 8, Plate 1), through which the steam circulates, is only 4-tenths of an inch instead of 4 inches, and the capacity of the interior cylinder would be sufficient to receive twice the quantity of wood. The serpentine, either of iron or of copper, would be much longer, occupying the whole length of the apparatus, and being enveloped by a cast-iron cylinder, D, Fig. 3, having two openings at the posterior end, by which the flame could be directed either upon A or B, Fig. 2, Plate 1; the fire-place, F, is smaller and shallower. The cast-iron cylinder serves as a stove to dry the wood intended to be carbonized, and will be heated by the smoke only of the fire-place, not by steam. The process proceeds thus: the smoke of the fire-place enters with the flame into the cylinder which envelops the serpentine, D, and at its extremity proceeds to the right or to the left, according to the aperture opened, to one or other of the cylinders, A or B, and thence proceeds to envelop and heat the cylinder C, whence it ultimately escapes by the chimney. In a similar manner the steam, by a furcation of the serpentine, can be directed into A or B at will. The three cylinders, A, B, C, are always kept charged. If A be in course of carbonization, the wood in C is drying by the smoke, and that in B by the heat acquired by the apparatus. When the carbonization in A is completed, and the charcoal removed, the vapour is directed upon B, and the dried wood in C is shifted into A; so that the wood will be subjected to the final process after having been perfectly dried, by which a great saving of time and fuel may be anticipated.

As it is important to keep the works in action for a considerable time, both as regards the uniformity of the product and economy, the charcoal should be stored in a proper magazine. This is built as represented, Plate 1, Fig. 4, being a semi-cylindrical chamber of masonry, A, within a mass of masonry, B, having at each end a small cast-iron door, D, at which the charcoal is extracted, and an orifice, C, by which it is introduced. It is raised above the ground on a masonry foundation, M, and the charcoal is therefore secured from damp as well as from direct contact with the air, and will remain for a long time free from deterioration.

M. Violette gives also a tabular view of the strength of powder manufactured with the red steam charcoal, as ascertained both by the balistic pendulum and the spring Eprouvette. In each case ten trials were made in comparison with the best proof powder of each denomination, but I shall give only the mean result, and the extreme difference from that mean.

Nature of Powder.	Mean of ten trials with Eprouvette.		Balistic Pendulum, Charge 4¾ oz.	Remarks.
	Powder under Trial.	Powder, Proof.	Velocity of Ball.	
	°	°	Feet.	
Fine sporting powder.	18·00	14.15	1168½	Extreme difference: 0°·5 — Do. P. P. 0°·35 +
Superfine Do.	19·80	17·05	1173¼	0·5 — Do. „ 0·8 —
Extra fine Do., formerly royal.	21·35	17·30	1253¼	0·4 + Do. „ 0·3 —
				The density of the powder was 0·860 for the two first, and 0·862 for the last.

In these experiments the uniformity of strength is about equal to that of the proof powder, whilst the absolute strength is very considerably greater. The regulations of the French Powder Department require for each denomination the following velocities of ball. Fine, 1082½ feet; superfine, 1148 feet; extra fine, 1230 feet per second, each of which is less than that obtained from the steam charcoal powder; and in the Eprouvette the powder is rejected if the number of degrees falls short by more than 1°·5′ of that given by the proof powder, whereas in these trials it has uniformly exceeded it.

This part of the subject may be closed by a summary of M. Violette's observations on the effects of uncertainty in the nature of the charcoal.

In ordinary sporting powder the proportions are for each 100:—sulphur, 10; saltpetre, 78; charcoal, 12; but such a definition is most uncertain so long as the nature of the charcoal is undefined, since the black charcoal procured from different processes, and even the several varieties of red, are, in fact, different substances. It is thus that the powder manufactured at Ripault, with charcoal made in iron cauldrons, the percentage at the utmost being 20, differs essentially from that made at Esquerdes, with charcoal the percentage of which was between 30 and 40; and it is probable that, under the same weight, these two forms of charcoal do not contain the same amount of carbonized and hydrogenized principles. This is evidently a subject of great interest as regards the improvement of powder, and M. Violette purposes to undertake a close chemical examination of all the varieties of charcoal produced. In a preliminary experiment, he found, that, whilst by very careful calcination the black charcoal lost only 21 per cent. of its weight, the red lost 42 per cent., so that the red charcoal actually contained twice the quantity of volatile matter, and a third less of real charcoal; the composition of the powder becoming comparatively thus:—

Black charcoal used . . . . 78 saltpetre; sulphur, 10; charcoal, 12.
If red, and the same apparent weights . . . . 78 „ „ 10 „ 8·77.

I shall only add to this brief sketch of M. Violette's views on this very important part of his subject one remark: namely, that in the red charcoal true carbonization can scarcely be said to have commenced, though the coherence of the fibrous tissue has been destroyed, and a large portion of the volatile matter expelled. The colour is probably due to the development of the peroxide of iron, which is afterwards veiled by the intense black colour of the charcoal when fully formed.

The application of heated steam to other chemical processes has also been tried, and M. Violette is of opinion that, by a judicious regulation of the temperature, the result of distillation may be so modified as to insure a larger quantity of vinegar, of spirit, or of tar, as the necessity of the case may require.

Of other applications of this process mentioned by M. Violette, I shall only notice those to the baking of bread and biscuit, and to the cooking of meat. In 1846 M. Violette submitted to the Academy of Sciences a memoir on this subject, and pointed out that steam, heated to 482°, afforded an excellent means of baking bread. Steam at a pressure of 1 to 2 atmospheres had indeed been applied to this purpose, by causing it to circulate between two enveloping cases of the oven, but in that arrangement only a small oven could be used. In M. Violette's arrangement, the oven may be of any requisite size, the loaves may be placed in successive tiers, so that any number may be baked in an hour, by the current of heated vapour passing through them. The dough immersed for half an hour in vapour heated to 482° was perfectly baked, exhibiting a pleasing gilded colour, and possessing a sweet agreeable flavour. A loaf 4½ lbs. weight was thus baked, and M. Violette considers the process fitted as well for the finest pastry as for common bread, and as at once economical and expeditious. Applied to the baking of sea biscuits for the Navy, it accomplishes by one process what is now effected by two, viz., baking in the oven, and drying afterwards in a stove; excellent biscuit was thus made ready for packing in half an hour. The Minister of Marine purposely sent an engineer to Esquerdes to witness the operation, and it will be doubtlessly tried on a large scale for the French marine. I am enabled by the able officer who presides over the victualling establishment at the Clarence yard to give the following statistics of that establishment. The biscuit is baked in ovens heated by flues; each oven requires 816 lbs. of coal for a day's work; each baking occupies 20 minutes. The charge is 1 cwt., and the quantity baked per day 48 cwt.

The biscuit requires 3 days' drying in the drying room before it can be packed up. At present we have not the means of comparing these quantities with those of the steam process. Mr. Grant's data give a proportion of about 1 lb. of fuel to 6½ lbs. of biscuit. The production of charcoal by steam required, with the original apparatus, 2·8 lbs. of fuel for 1 lb. of charcoal, and that would doubtless be reduced below 2 lbs. with the proposed modifications. It is, however, difficult to reduce the one process to the other. As the time of exposure is less than one fourth that required for making charcoal, it may at least be assumed that the quantity of fuel for 1 lb. of biscuit could not be more than a quarter of a pound, supposing the same temperature necessary; that is, 1 lb. of fuel would bake and dry effectually 4 lbs. of biscuit; but there are here no volatile products, such as tar, &c., to be removed, and a temperature of only 482° is required, whereas perfect carbonization to the point of red charcoal is effected at a temperature between 572° and 630°, so that it may be reasonably believed that 1 lb. of fuel would bake at least the same quantity as in the Clarence yard establishment, and at the same time effect a perfect drying of the biscuit. Meat may be roasted in the same way, and wood dried; the first of these objects is important, as affording an amelioration of the soldier's diet, now limited, as regards flesh, to boiled meat; and the latter is of the highest importance as regards our marine, always keeping in view the great difference between the action of steam at the ordinary temperature and pressure and that of highly heated steam, which is one of the most powerful of desiccating agents.

The French Minister of War has already seen the value of such a ready and effectual mode of drying timber, and it is hoped that it will, ere long, engage the attention of the British Admiralty, and of the Carriage Department of the Ordnance.

J. E. P.

No. 5.

COPY of REPORT on the Demolition of the old MAGAZINE in the CITADEL at HALIFAX, NOVA SCOTIA, on the 7th of April, 1847, by LIEUT. PHILLPOTTS, Royal Engineers. By permission of the Inspector-General.

Description.

THE magazine was built in the year 1812, of rough rubble masonry. The arch was built of brick, and turned in one ring. The crown of the arch was slightly cracked, owing, it is supposed, to the settling of the masonry.

The ground on which the magazine was built is considerably above the level of the interior of the fort, and it was accordingly left standing on a mound of earth, the top of which was about 9 feet above the level of the surrounding ground.

The following were the dimensions:—

Exterior length	. . .	62 feet.
„ breadth	. . .	30 „
Interior length	. . .	50 „
„ breadth	. . .	16 „

The side walls, consequently, were 7 feet thick, and the ends 6 feet thick; at the foundations the walls were increased in thickness by an offset on each side of 8 inches. There was a window in the north end, and a door in the south; the latter was covered by a ruined porch, which was taken down previous to commencing operations.

Method of demolition.

The demolition was effected in the following manner: charges of powder were lodged in the centres of the walls, there being 9 charges in each side wall, and 2 in each end, making 22 in all.

Charges.

The charges were placed at two-lined intervals from each other. Those in the sides were 15 lbs. each, except the ones in the four angles, which were increased to 16 lbs. Those in the ends were 9 lbs. each; they were lodged by driving small galleries from the interior of the building into the centre of the walls.

On commencing the galleries, it was found, owing to the frost having penetrated a considerable depth into the mortar, very difficult to loosen the stones. After the first day fires were therefore lighted along the walls, and allowed to burn for a couple of hours. This was found greatly to facilitate the work. Chambers were made at the back of the galleries, with some old brickbats; thus rendering it easier to tamp round the charges without disturbing them.

Tamping.

The powder was placed in canvas bags, which were surrounded with shavings and sawdust. The tamping was effected with clay dug from the centre of the magazine. The stones taken from the walls were piled up at the mouth of the galleries and embedded in clay.

Hose.

The hoses leading from the charges were half-inch, arranged so as to fire simultaneously, and all brought to one point, where they were ignited by a galvanic battery, which was placed in a casemate close at hand. All the hose under the tamping was secured in deal casing, and the remainder was tied to rope and nailed down to planks laid along the centre of the magazine.

The charges being fired, the foundations were blown away, the walls rose about 3 feet, and, falling with a low rumbling sound, crumbled to pieces, hardly two stones being left together. Not a stone was blown 50 yards from the building.

The arch, of course, fell in; all the charges exploded except the four in the North Angle, which was consequently left standing.

Three days after, the hose of the unexploded charges was got at by removing the ruins, and was found to have been cut through (supposed by a stone) at the point marked (*a*) in the plan. These hoses were, however, fired by a port fire, and the result was similar to the previous one.

The demolition was most complete, and the magazine now presents the appearance of a shapeless mass of ruins.

Number of Men and Time employed in the demolition.

No. of Men.	No. of Hours.	Date, 1847.
1 N. C. O. 6 Men	8½	March 24
„ 8 „	8½	„ 25
„ 9 „	8½	„ 26
„ 11 „	4	„ 27
„ 10 „	8½	„ 29
„ 8 „	8½	„ 30
„ 8 „	8½	„ 31
„ 10 „	9½	April 1
„ 9 „	4½	„ 3
„ 8 „	9½	„ 5
„ 11 „	9½	„ 6
2 „ 30 „	8	„ 7

Two men were also employed during the above time making powder bags, and making and filling powder hose.

Owing to the nature of the work in question, it was not considered necessary to keep a regular diary of its progress, the execution of some of the galleries being attended with great difficulty, and that of others with comparative ease. From observation it was found that, before making the fires in or along the walls, it took two men about 24 hours to complete the gallery and chamber. After the fires were resorted to, it was found that, on an average, only 16½ hours were required to complete the same with the same number of men. Of this 16½ hours, the men were only 12 hours actually at work at the mines, the remaining 4½ hours being occupied in making the fire to thaw the mortar, and in allowing the stones to cool. The formation of each required half an hour.

If the work had been executed in summer, there would have been no necessity for using fires, and consequently the men might have had the chambers ready for the reception of the charges in 12 hours.

The men did not work except during the regular working hours, with the customary intervals of breakfast and dinner.

The galleries were of no particular size or dimensions, being made as small as convenience and the nature of the masonry would allow, care at the same time being taken that the bottoms of the chambers should be all on the same level.

The tools used were crowbars, masons' picks, iron wedges, and sledge hammers.

The tamping was effected by a party of 2 N. C. O. and 30 men. I commenced laying the charges at 6½ A.M., and by 2 P.M. they were all ready for firing, with the exception of connecting them by the hose along the centre of the magazine.

The demolition of the magazine not being considered in the light of an experiment, the method adopted was used as the one considered most likely effectually to accomplish it with the least expense.

From examining the angle of the magazine left standing after the first explosion, and from observing that a great portion of the circle, from the springing line about half way up to the crown, was left standing, not having been in any way affected by the falling of the portion opposite, I do not think that, by using "alternate charges not opposite to one another," the demolition would have been effectually accomplished unless these charges were considerably increased, and thereby causing a violent demolition; a result which it was of the greatest importance to avoid, on account of the situation of the building.

HENRY PHILLPOTTS,
Lieut. Royal Engineers.

no. 6.

ACCOUNT of the OPERATIONS performed in the FIELD DAY which took place at CHATHAM, on the 11th August, 1848, in the presence of LIEUT.-GENERAL SIR JAMES L. LUSHINGTON, G.C.B., Chairman; MAJOR-GENERAL A. GALLOWAY, Deputy Chairman; and the COURT OF DIRECTORS of the HONOURABLE EAST INDIA COMPANY; the HONOURABLE FOX MAULE, Secretary at War; and MAJOR-GENERAL SIR J. F. BURGOYNE, K.C.B., Inspector-General of Fortifications.

IN carrying on the instruction of the junior officers and men, both of the Royal and East India Company's Engineers and Sappers and Miners, in the spring of the year 1848, parallels, approaches, and batteries were thrown up on the practice ground of the Royal Engineer Establishment, in the space comprehended between the permanent works on the left of Chatham lines, and the old field works extending from Prince Edward's Bastion to Terrace Bastion; and in the months of July and August, works representing ordinary siege operations were pushed forward by the flying sap, and by the regular single and double saps, until a lodgment was made upon the glacis of the ravelin, as shown in the plans (x and z).

Simultaneously with the latter part of the attack, countermines were made by officers and men representing the besieged force.

With the view to the further instruction of the officers and men of the Royal Engineer Establishment, and also to impart information on siege operations to some of the officers and men of the garrison of Chatham, it was determined, by permission of Colonel James Simpson, the Commandant, to have a field-day of engineer operations; and the Court of Directors of the Honourable East India Company signified their intention to be present, and fixed Friday, the 11th of August, 1848, for the occasion.

The operations were divided into four heads:—

1stly. The escalade of the outer line of permanent works;

2ndly. The occupation of the trenches above stated, by driving the garrison within the inner line;

3rdly. The capture of that line, by breaching the ravelin by mines, and afterwards storming the breach;

And 4thly. By an attack on the Duke of Cumberland's and the Terrace Bastions.

GENERAL DESCRIPTION OF THE FIRST OPERATIONS.

(See Plan No. 1.)

The troops representing the garrison, under the command of Lieut.-Colonel T. E. Kelly, of the Provisional Battalion, consisted of a squadron of Dragoons under the command of Captain J. B. Pilgrim, of the 15th Hussars; a company of Sappers and Miners, under the command of Captain D. W. Tylee, of the Royal Engineers; the Provisional Battalion, under Lieut.-Colonel T. E. Kelly; the Royal Marine Artillery commanded by Lieut. G. A. Schomberg, R.M.A.; and the Royal Marines, under Lieut.-Colonel T. Stevens, R.M.

The attacking force was divided into four columns:—

1st. A column of reserve, under the command of Captain W. K. Stuart, of the 86th Regiment.

2nd. The right column, consisting of Royal and East India Company's Sappers and Miners, under the command of Captain J. G. M'Ker ., of the Royal Engineers;

3rd. The centre column, composed of the Royal Artillery, under the command of Captain W. T. Crawford, R. A., and of the right wing of the 17th Regiment, under the command of Lieut.-Colonel P. M'Pherson, C.B., 17th Regiment.

And 4th. The left wing of the 17th Regiment, under the command of Lieut.-Colonel J. Stoyte, of the 17th Regiment, formed the left column.

The three columns of attack were drawn up, in Echellon, at "quarter distance," near the Gillingham Road, at about 300 yards from the ramparts.

The column of reserve was posted at some distance to the rear, in Gillingham Lane.

In front of bo the centre and the left columns 24 ladders were placed; one half for the scarp, and the other half for the counterscarp.

Under the command of Captain M'Kerlie, R.E., were two boats, with officers and crews, having powder-bags, for the purpose of breaching the stockade on the left of the lines, as well as the brick inclosure wall of the fire-barns, which formed the key of the left of the position.

On the order being given to advance, the three columns and the parties with the ladders moved on together, and the boats were pulled towards the landing place.

The sentries of the fortress gave notice of the approach of the assailants by firing their muskets, and the garrison marched down to the ramparts, and lined the parapet, opening a heavy fire upon the advancing columns.

The light company of the 17th Regiment, and skirmishers of the Sappers and Miners, were thrown out to cover the whole front of attack. They moved up at "the double," to the crest of the glacis, laid down, and maintained a sharp fire on the gunners and infantry of the garrison.

In the meanwhile the columns advanced with their ladders, and when near the foot of the glacis, the left column, being attacked by a sortie of cavalry, "formed square," and opened a fire upon their assailants.

The reserve, posted behind a fence, where they were secure from attack, opened a flanking fire on the cavalry, who after three successive attempts to force the square, retired within the lines.

The boats' crews pulled up the creek; the detachments of Sappers and Miners landed from them, and by exploding charges of gunpowder against the stockade and boundary wall of the fire-barns, made practicable breaches in both. (See Appendix, A and B.)

The column of Sappers and Miners then rushed forward, and, by driving the enemy from the fire-barns and occupying them, turned the flank of the position, and the escalade was the more readily effected by the centre and left columns, who, on mounting the ramparts and gaining possession of the guns in battery, deployed on the terreplein, and opened a fire on the retreating troops.

This may be supposed to be the close of the first operations.

The general arrangements for the attack and defence were directed by Colonel Sir Frederic Smith, K. H., of the Royal Engineers.

Lieut.-Colonel A. R. Harrison, R. A., directed the Royal Artillery operations of the day.

Captain C. Fanshawe, of the Royal Engineers, conducted the escalade, and afterwards assisted in the general arrangements of the attack.

Captain H. St. George Ord, of the Royal Engineers; Lieut. Lane Fox, of the Grenadier Guards; Lieut. A. C. Gleig, of the Royal Artillery; and Ensign Dowbiggen, of the 71st Highlanders, acted as staff-officers.

SECOND OPERATIONS.

The garrison retreated, disputing the ground between the outer and inner lines by occupying the reverse of the trenches, from which, by the advance of the assailants, they were successively driven, until at length they retired to the interior of the inner line.

The guns and howitzers of the ramparts of the outer line were turned upon the garrison by the Royal Artillery, who headed the second column of attack.

The assailants, having at length occupied the fourth parallel, the trench cavalier, and the lodgement on the glacis, briskly returned the fire of the garrison, which was kept up from the left face of the ravelin and the right face of the Duke of Cumberland's Bastion. The parapets of these works were furnished with loop-holes, formed of logs of wood and sand-bags.

THIRD OPERATIONS*.

Captain the Hon. Alexander Gordon, and Lieut. Lane Fox, of the Grenadier Guards, and Lieut. H. Y. D. Scott, of the Royal Engineers, as part of the garrison, having formed mines under the trench cavalier and the heads of the two saps, and notice having been given of their intention to fire them, the more advanced parties of the besiegers were withdrawn, to avoid accidents. (See Appendix C.)

The explosions having destroyed the works against which they had been directed, the Sappers and Miners, under Captain J. G. M'Kerlie, R.E., were pushed forward, and crowned the entonnoirs by flying sap.

The assailants finally fired three charges, which had been placed by Captain P. I. S. Barry, Royal Engineers, under the salient of the ravelin; and two behind the counterscarp, forming thereby a practicable breach in the scarp, and an easy descent into the ditch.

The garrison retired from the ravelin as the besiegers ascended the breach; and, on the latter having completed their lodgement, the "cease firing" was sounded.

FOURTH OPERATIONS.

In order the better to practise the officers and soldiers employed, the following change took place in their disposition.

The former garrison became the assailants, with the addition of two companies of Sappers and Miners; and the former assailants, with one company of Sappers and Miners, became the garrison of the front, comprehended between the salients of the Duke of Cumberland's and the Terrace Bastions. The cavalry were also now added to the besieging force.

The Sappers and Miners of the garrison were stationed in the redoubt, in the parapet of which they placed 12 fougasses. They also lodged charges under the stockade at the gorge of that work.

The attack commenced by a brisk fire of musketry from the first parallel, and of artillery from the batteries in front of it. The garrison returned this fire with its artillery, and with musketry protected by a loop-holed parapet.

The assailants gradually advanced along the approaches; and, aided by a sharp fire from the advanced trenches, a company of Sappers and Miners carried the redoubt by escalade. The garrison retreated from this work, previously lighting the hoses attached to the fougasses, and to the charges under the stockade.

* This may be conceived to be the resumption of a siege operation suspended for want of means; and, on the arrival of reinforcements, the slow process of a regular siege was converted into an "*attaque accélérée*."

The assailants, observing these matches burning, retreated, and immediately afterwards the 12 fougasses exploded, and levelled the parapet, whilst simultaneously therewith the stockade was effectually breached by the explosion of the charges placed under it, so that the cover which that work would otherwise have afforded was destroyed. (See Plans 8, 9, 10, 11.)

The assailants next fired three charges, which had been placed by Captain D. W. Tylee, of the Royal Engineers, assisted by officers and men of the East India Company's Service, under the salient of the Duke of Cumberland's Bastion. (See Appendix F.)

These mines made a breach of easy ascent, which was then stormed by the left wing of the attacking force, while the right wing advanced with ladders and escaladed the Terrace Bastion. The cavalry, at the same time, advanced to the curtain, and rode through the barrier, which had been opened by the Sappers and Miners, who first mounted the breach.

FREDERICK SMITH,
Colonel Royal Engineers,
Director.

FIELD STATE of the TROOPS engaged in the SIEGE OPERATIONS at CHATHAM, on the 11th of August, 1848.

Regiment, Corps, or Depôt.	Field Officers.	Captains.	Subalterns.	Staff.	Staff Sergeants and Sergeants.	Trumpeters, Buglers, and Drummers.	Rank and File.	Total.
Cavalry Depôt	...	2	2	...	3	1	46	54
Royal Artillery	1	1	4	2	6	1	147	162
Royal Engineers and Royal Sappers and Miners	1	3	40	1	12	2	284	343
East India Company's Engineers, Sappers and Miners, &c.	...	...	22	...	3	...	[illegible]	87
The 17th Regiment	2	5	17	3	31	15	520	593
Royal Marine Artillery	...	...	1	...	3	...	53	57
Royal Marines	1	4	3	1	21	8	248	286
Provisional Battalion	1	10	13	2	74	21	801	922
Total engaged	6	25	102	9	153	48	2161	2504
KEEPING GROUND.								
Royal Marines	...	...	...	...	4	...	104	108
Invalid Depôt	...	...	...	...	10	...	200	210
Total keeping ground	...	...	...	...	14	...	304	318
General Total	6	25	102	9	167	48	2465	2822

APPENDIX A.

REPORT of the CONSTRUCTION of a STOCKADE, erected near the Bathing Pond, and breached by Gunpowder, on the 11th of August, 1848. (Sketch No. 2.)

A stockade was erected across the isthmus which separates the left ditch of St. Mary's Hornwork from the Bathing Pond, to secure the left flank of the position; and the adjoining inclosure-wall of the fire barns was loop-holed for the same object. The stockade was composed of timbers, of an average length of about 12 feet, placed on their ends, in a trench 3 feet deep. The ground was well rammed, so as to give the timbers a firm hold; and the timbers were connected together by means of ribands, about 12 inches wide and 4 inches thick, which were firmly spiked to them.

A breach was effected on the 11th of August, 1848, at the north end of the stockade, sufficient for the passage of about 12 men abreast, by the explosion of two charges of gunpowder, each consisting of 100 lbs., and separated from each other by an interval of 6 feet. Both charges were placed in waterproof bags, to each of which there was attached 6 feet of Bickford's fuze. To each charge were added three bags, each containing about 1 cwt. of common earth, which were placed, one on the top and one at either end of the charge. The charges were fired simultaneously *.

W. C. HENDERSON,

Ensign E. I. C. Engineers.

APPENDIX B.

REPORT of the BREACHES made by GUNPOWDER, in the INCLOSURE-WALL of the FIVE BARNS, on the 11th of August, 1848. (Sketch No. 3.)

The inclosure-wall of the Five Barns is composed of brickwork, 14 inches thick, with piers at intervals of 10 feet, and is 10 feet high.

To secure the left flank of the position, on the 11th of August, 1848, in addition to the erection of a stockade across the isthmus which separates the left ditch of St. Mary's Hornwork from the bathing pond, the adjacent inclosure-wall of the Five Barns was occupied, and loop-holes were formed by means of musket-proof timbers, raised 3 or 4 inches above the coping of the wall.

A banquette was formed by placing large casks upon their ends, and laying thereon chesses and planks.

This post, on the occasion of the siege operations, was occupied by a company of Sappers and Miners, commanded by Captain D. W. Tylee, Royal Engineers.

In attacking this position, orders were given for lodging the two charges intended to breach the wall, with a space of only 6 feet between them; but, by some mistake, the charges were placed 10 feet apart, and therefore, instead of one large breach being formed, sufficient for 10 or 12 men abreast, two separate breaches were made of the dimensions shown in the accompanying drawing (No. 3), which were, however, sufficiently large, each to admit of the passage of two or three men abreast.

* The north end of the stockade alone was breached, in order to avoid an useless waste of timber.

Each charge consisted of 60 lbs. of gunpowder (having 6 feet of Bickford's fuze attached to it) in a waterproof bag, and sand-bags filled with common earth were laid on each, in the manner described in the drawing (No. 3), to increase the effect against the wall.

(Signed) A. J. CLARKE,
Lieut. Royal Engineers.

APPENDIX C.

REPORT of the COUNTERMINE OPERATIONS, conducted by CAPTAIN the HONOURABLE ALEXANDER GORDON, and LIEUT. LANE FOX, of the Grenadier Guards, against the attack on the RAVELIN, and on the DUKE of CUMBERLAND'S BASTION, on the left of Chatham Lines, in the Months of July and August, 1848. (Plan, No. 4.)

The ordinary works of a siege having been sufficiently advanced, the above-named officers were desired by Colonel Sir Frederic Smith, K.H., to destroy by countermines the trench cavalier, and the right double sap of the offensive works, so as to open them to the fire of the garrison.

The operations were ordered to be carried on, as if in presence of the enemy, without the assistance of any measurement being taken outside the ditch of the ravelin.

Having no plan nor section of any part of the works, we first measured a base-line on the banquette of the ravelin, opposite to the works to be destroyed, and from thence fixed, by triangulation, the two ends of the cavalier, and the beginning and head of the double sap. We also took angles of depression to each of the above-named points.

We then fixed, by triangulation, the position of the mouth of one of the galleries in the counterscarp of the ravelin, and its level below the base-line, on the banquette.

We afterwards placed the theodolite on a low stool, and surveyed the two galleries we intended to use, as far as they were already made, and then calculated in the usual way, the rise or fall, and the direction necessary to be given to the new branches, in order to arrive at the points where we proposed to place the charges, which were as follows:—

FOR THE TRENCH CAVALIER.

The survey having given a front of 96 feet, at the foot of the interior slope of the cavalier, and taking the width of the base of the parapet to be 20 feet, a charge placed at 10 feet below the natural surface of the ground, and 1 foot in advance of the crest of the parapet (to compensate for the rise of the glacis in front), would give two equal lines of least resistance, of 13 feet each, one to the foot of the exterior slope and one to the terreplein of the cavalier.

Then, by using two charges, and placing one of them so that the edge of the crater would cut the right shoulder of the cavalier at the foot of the interior slope, and the other so as to leave a space of 14 feet between the two craters (it being intended that each crater should be 26 feet in diameter), we expected the earth between the two would fall away, leaving an inverted cone about 7 feet high (the base being 14 feet), so that it would afford no cover against the fire of the ravelin; while the remaining 30 feet of the cavalier, uninjured on the left, but reduced at the crest of the parapet to about 20 feet, in consequence of the earth falling away to an angle of 45°, would be open to the flanking fire of the Duke of Cumberland's Bastion.

FOR THE DOUBLE SAP.

The quantity of gunpowder being limited, it was judged expedient merely to open the left face of the double sap, by placing a charge 10 feet below the natural surface of the ground, so as to throw down the left parapet and the foremost traverse on the same side. This would expose about 50 feet of the sap to the fire of the garrison, partly from the ravelin, and partly from the right face of the Duke of Cumberland's Bastion.

The cases used in all the branches were of 2-inch pine, 3 feet 7 inches by 2 feet 5 inches in the clear.

At about 100 feet from the mouth of the west gallery a guard chamber was made, of great gallery cases, 7 feet by 6 feet 6 inches, and 6 feet 6 inches high, for the convenience of keeping stores, &c.

The two charges for the cavalier were of 219 lbs. each, in boxes 20½ inches cube, with a space of 1½ inch between the surface of the powder and the top of the box. The joints of the boxes were secured with white lead, and the outside coated with pitch. The chambers were no larger than actually necessary to receive the boxes. 36 feet of ¾ inch powder hose, and the same length of Bickford's fuze, were attached to each, laid together in 2½ inches casing tubes, brought to one focus of ignition above the junction of the two branches leading to the chambers, and finished in the usual way with a piece of portfire 3 inches long, placed horizontally in clay.

The soil in the neighbourhood of both these charges was of fine sand mixed with clay.

Each gallery was tamped for 23 feet, a wall of clay bricks, hardened in the sun, being built every 3 or 4 feet, and the interval filled with earth well rammed. The earth for tamping was obtained from a gallery driven for the purpose, opposite to the junction of the two branches, which was found to be more expeditious than bringing earth from the mouth of the mine, as there were two branches to tamp at once.

The charge for the mine under the double sap was of 100 lbs., in a box 15½ inches cube, with the space of 1 inch between the surface of the powder and the top of the box. 27 feet of ¾ inch powder hose, and the same length of Bickford's fuze, were attached to it, and led into the guard chamber for ignition.

The gallery was tamped for the extent of 16 feet, in the same way as the other two.

The soil in the neighbourhood of this charge was clay mixed with flints.

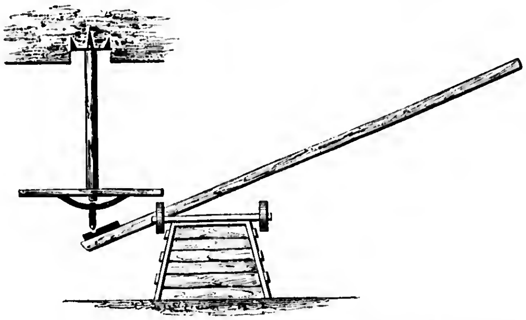
The *actual* effect of the explosions was a little more than the *calculated* effect (as shown by the plan and sections), the whole of the cavalier and 55 feet of the double sap being opened to the fire of the ravelin or bastion.

While driving the galleries, it was found necessary to bore an air-hole, to obtain fresh air from the surface, two pairs of bellows being insufficient to drive out the foul air which had collected during the few days one of them had not been worked.

A spot was therefore selected for boring, which it was calculated would bring the air-hole to the surface of the ground at the foot of the exterior slope of part of the offensive works, so that it would be unperceived by the enemy.

A 6-inch auger, attached to boring rods 2 feet in length, was used; a piece of iron, 6 inches long, being fitted below the cross-handle in prolongation of the boring rods. This rested in a shoe or cup of iron, fixed on the thick end of a 6-feet handspike, which, being used as a lever, on a mining truck turned upside down, gave an upward pressure against the roof of the gallery. Two men could work this arrangement, one bearing on the lever, and the other turning the cross-handle of the boring rod. Of course a length of rod was added below every 2 feet.

Diagram, showing the Method adopted for boring an Air-Hole from the Floor of the Gallery.



(Signed) ALEXANDER GORDON,
Lieut. and Captain, Grenadier Guards.

APPENDIX D.

REPORT of the COUNTERMINE OPERATIONS conducted by LIEUTENANT H. Y. D. SCOTT, of the Royal Engineers, against the ATTACK on the RAVELIN and the DUKE OF CUMBERLAND'S BASTION, on the left of CHATHAM LINES, in the month of August, 1848. (Plan, No. 5.)

The portions of the gallery and branches marked *l a*, *a b*, and *a c*, in the Plan No. 5, and forming a part of a system of countermines under the glacis of the ravelin in front of Prince Frederic's and the Duke of Cumberland's Bastions, were already completed, when I received orders from Colonel Sir Frederic Smith, K.H., Royal Engineers, to destroy the head of the serpentine sap (constructed during the few previous days) by lodging below it two charges of 100 lbs. each. I found that 50 feet of the main gallery was cased with frames 3 feet 6 inches by 4 feet, and the remainder of it, and the branches, with frames 2 feet 5 inches by 3 feet.

To accomplish the duty intrusted to me, a return was driven from the main gallery, 5 feet, and the right branch *a b* prolonged for 8 feet, where a return of 5 feet was made at right angles to its direction, chambers, about 1 foot 6 inches cube, being made at the end of each return, to contain the charges.

The left branch, 24 feet in length, was at the same time tamped with the earth taken from these excavations, a step necessary to be adopted in order to give a sufficient resistance to the charge at *g*, and as affording, also, a short run for the earth removed. The frames (3 feet by 2 feet 5 inches) were, with the exception of a few sills, over which the casing tube was fastened down, all removed as the tamping proceeded.

The mines were ready for firing in 76 hours from the time the work was commenced, and the whole of it was performed by two reliefs of officers (Lieuts. De Vere and Luard, Royal Engineers) and three reliefs of men.

The following is a statement of the work done in each relief of 6 men.

7th.

1st relief, of 8 hours.

6 feet of right branch driven, and 2 feet of the return, for the charge at *g*. 10 feet of left branch tamped.

2nd relief, of 8 hours.

2 feet of the right branch driven, with its return of 3 feet, and the chamber. 2 feet of the return (to *g*) and the chamber, completed. 9 feet of the left branch tamped.

3rd and 4th reliefs, of 4 and 6 hours respectively.

Employed in making bricks of blue river clay, for tamping.

8th.

1st relief, of 6 hours.

Charge lodged at *f*, 18 feet of casing tube laid down, and 1 foot 6 inches of tamping executed with the bricks made during the two previous reliefs.

2nd relief, of 6 hours.

Tamped 4 feet; 2 feet 6 inches of this distance with bricks. An additional party of 6 men employed in carting the bricks for 3 hours.

3rd relief, of 6 hours.

Tamped 5 feet 6 inches.

4th relief, of 6 hours.

Tamped 6 feet.

9th.

1st relief, of 6 hours.

Charge lodged at *g*; the remainder of the casing tube (40 feet) laid down, and 2 feet of the return (to *g*) tamped with bricks.

2nd relief, of 6 hours.

3 feet of the return, and 3 feet of the left branch, tamped.

3rd relief, of 6 hours.

2 feet of left branch, 4 feet of right branch, and 11 feet of principal gallery, tamped.

4th relief, of 6 hours.

13 feet of principal gallery tamped.

The mines were ventilated by means of air-tubes and a pair of bellows, which were worked from the entrance of the gallery. The charges were contained in ¾-inch deal boxes, 14½ inches interior dimensions, payed over with pitch, and the casing tubes made to unite at the angles by a square joint, their upper and lower halves being fastened together by means of wooden pegs, and the Bickford's fuze and ¾-inch powder hose laid in them side by side. When laid down, they were well picketed to the ground, and covered with sand to protect them from the wheels of the trucks.

The bricks above mentioned were built up round the charge, and rammed hard, being not yet dry, so as to form one compact mass of stiff clay. The rest of the tamping was completed with well-rammed sand, carried 18 feet beyond the return to the charge at *g*.

The powder hose was so arranged as to fire the two charges simultaneously (see Fig. marked 3, Plan 5), and was ignited by a piece of portfire, introduced into its end, and bedded in clay to prevent sparks falling on the hose and lighting it before the portfire had burnt out.

The Bickford's fuse, extending a few inches beyond the powder-hose, was first lighted; and for this purpose portfire was used. I found no inconvenience from its smoke; but it must be observed that the end of the hose was only 60 feet from the mouth of the gallery.

The result of the explosion is shown on the Plan, No. 5.

H. Y. D. Scott,
Lieut. Royal Engineers.

APPENDIX E.

REPORT of the Mining Operations conducted by Captain P. J. S. Barry of the Royal Engineers, against the Ravelin, on the Left of Chatham Lines, during the months of July and August, 1848. (Plan, No. 6.)

Having received orders from Col. Sir Frederic Smith, K.H. and F.R.S., Royal Engineers, Director, to effect a practicable breach in the ravelin, on the 11th of August, 1848, in the review of field operations, I drove a descending gallery, at a slope of 1 in 2½, from the lodgement on the glacis, 20 feet long and branched off horizontally, to the right and left, to the distance of 5 feet. The deviation in the direction was at right angles. At the ends of these branches, and near the top of them, I formed chambers, in a return, each capable of containing a charge of 80 lbs. of gunpowder, having a line of least resistance of 8 feet. The object of these mines was to blow in the counterscarp.

The descending gallery was prolonged 12 feet, and then deviated at right angles to its former direction, and was carried on horizontally, under the bottom of the ditch of the ravelin, to a distance of 14 feet. From this point, an ascending gallery of 1 in 1½ was driven to the left 40 feet, the deviation in the direction being a right angle. At the respective distances of 15 feet, 30 feet, and 39 feet, horizontal branches were driven, at right angles, to the left, to a distance of 10 feet each, and charges placed in returns, as shown in plan, viz.:—

At 15 feet, a charge of 100 lbs. of powder, and line of least resistance of 8 feet.

At 30 feet, a charge of 80 lbs. of powder, and line of least resistance of 8 feet.

At 39 feet, a charge of 60 lbs. of powder, and line of least resistance of 8 feet.

Having laid the powder hose in the casing tubes, the whole length of the gallery and branches was tamped with sand; the frames being taken out, as the tamping proceeded.

In front of the boxes containing the charges, I used blue clay made into bricks, in order to expedite the work.

The tamping proceeded at an average rate of 15 inches per hour.

A piece of portfire, 3 inches in length, was attached to the end of the powder hose, to give time for retiring after lighting it.

The explosions were nearly simultaneous, and, as represented in the Plan and Section, produced a practicable breach for cavalry if required.

(Signed) P. J. S. Barry,
Captain Royal Engineers.

APPENDIX F.

REPORT of Mining Operations conducted by Captain D. W. Tylee of the Royal Engineers, against the Duke of Cumberland's Bastion, on the left of Chatham Lines, during the Months of July and August, 1848. (Plan No. 7.)

I received orders from Colonel Sir Frederic Smith, K.H., Royal Engineers, to effect a practicable breach in the Duke of Cumberland's Bastion, on the left of Chatham lines, on the field day of siege operations, Friday, 11th August, 1848.

I was obliged to throw up a French cavalier, to cover me from the view of the supposed enemy posted on the Duke of Cumberland's Bastion, from the point at which I was about to commence operations (marked C in Plan, No. 7).

After having thus obtained cover, I sunk a shaft 5 feet 6 inches in diameter and 10 feet deep, which was found to be necessary, in order to allow a sufficient thickness of earth between the top of my gallery frames and the surface of the road I had to pass under to reach the escarp of the face of the bastion—a distance of 84 feet 6 inches, horizontally. I ascertained, by taking the levels from the shaft to the escarp, that if I sunk the shaft 10 feet deep I should then, in passing under the hollow of the road, have 3 feet 6 inches above my frames, which I considered sufficient.

Having done this, I advanced at an angle of 83° with the salient part of the left face of the bastion, and with a rise of one foot in one, to the distance of 15 feet. I then formed a horizontal landing for the width of the mine frame.

From that landing I drove a branch towards the shoulder of the bastion, at right angles to the gallery, with small frames, for the distance of 8 feet, with a rise of 3 feet 6 inches, which gave me a line of least resistance of 9 feet.

I then proceeded from the same landing, for the distance of 12 feet, with a rise of one in two, and formed another landing, similar to the former.

I next drove a branch, also at right angles to the gallery, with small frames, for the distance of 8 feet, with a rise of 3 feet 6 inches, which gave me a line of least resistance of 10 feet.

From the second landing I then proceeded, for the distance of 12 feet, with a rise of 6 feet 8 inches, and formed another landing.

I then drove my last branch with small frames, at right angles to the gallery, horizontally, for the distance of 8 feet, which gave me a line of least resistance of 8 feet.

After having proceeded thus far, I obtained my charges of gunpowder from the magazine in boxes, coated over with tar, and having powder hose and Bickford's fuse fixed in each.

My *first charge* was in a box, and consisted of 80 lbs. of gunpowder. Line of least resistance, 9 feet. Size of box, 13½ inches, cube.

Second charge, 100 lbs. of powder, in a box of 14½ inches, cube. Line of least resistance, 10 feet.

Third charge, 60 lbs. of powder, in a box of 12 inches, cube. Line of least resistance, 8 feet.

After having got my charges all ready at the mouth of the gallery, I proceeded to place them in their respective destinations. I found some little difficulty in conveying them up the first ascent, which was at an angle of 45°, but eventually, with the assistance afforded by the several officers of the Hon. East India Company's Engineers, and the non-commissioned officers and men of the Royal and East India Company's Sappers and Miners, attached to me during the operations, I succeeded, without any considerable delay, in fixing the several charges in their proper positions. I had them all placed before I commenced to lay to my casing tube and powder hose, in order that to save time the latter operation might be performed simultaneously with the tamping from the whole of the three charges along the branches.

In tamping, I found that from the steepness of the slope I could not remove all the frames as the work proceeded and tamp with earth; I was therefore obliged to use for this purpose sand bags, and moist clay formed into bricks.

The method pursued in laying the casing tube, so that the whole of the charges should explode simultaneously, or nearly so (as shown in the diagram), was as follows:—

I first placed the casing tube under the holes made in the boxes containing the charges, in which the powder hose and Bickford's fuse were inserted; I then laid the powder hose and Bickford's fuse, from each box, into the casing tube, and cut my casing tube off to the length of the branches, and tamped the branches. I then united a piece of casing tube to that leading from my upper charge to the gallery, and then brought it down to about 15 feet along the horizontal gallery, which was my focus of ignition. I fired them from that point by means of a piece of port-fire, 2 inches long, attached to the hose, lighted by a slow match; I having two minutes thereby in which to retire before the explosion took place.

The casing tube from the second or centre charge was joined to that from the upper charge; and the casing tube from the lower charge was united to another piece, brought down by one side of the gallery, connected to another small piece, again brought up, and lastly joined to the main casing tube, so that the time that it would take for the hose to burn from the point of ignition to the upper charge might be equal to the time that it would take from the point of ignition to pass along the tube, when laid, as shown in diagram.

The lower charge exploded first, then the second, and lastly the third. By the 1st and 2nd exploding before the 3rd it loosened the earth in a downward direction; and therefore, when the 3rd exploded, the effect tended in that direction more than in an upward one, and did not cause so much damage to the platform of the gun as might have been expected.

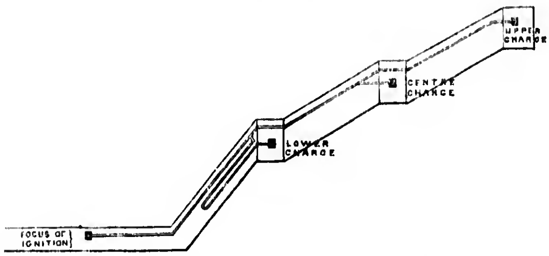
The breach effected by the three explosions was perfectly practicable, as was proved by the manner in which the infantry troops mounted it; and it was equally practicable for cavalry, if it had been necessary for them to have ascended.

The total length of tamping was 42 feet, including the branches, which occupied 3 reliefs of 6 hours each.

I found that the tamping with sand bags and bricks could be performed in much less time than the tamping with earth.

A diagram showing the positions of the three charges, and the manner in which the casing tube was laid, &c., is herewith annexed.

DIAGRAM.



(Signed) D. W. TYLEE,

Captain Royal Engineers.

no. 1.

MEMORANDA descriptive of the ATTACK, by the BOERS, of the FORCE under command of MAJOR SMITH, 27th Regiment, in the INTRENCHED CAMP at PORT NATAL, in May and June 1842; with a few NOTES relative to the subsequent OCCUPATION and SETTLEMENT of the DISTRICT of NATAL, SOUTHERN AFRICA. By LIEUT. GIBB, Royal Engineers.

BATTLES with barbarians, or operations against an undisciplined foe, are rarely worth recording, as, in these cases, it is constant practice which alone can give the experience necessary successfully to cope with an enemy carrying on a system of harassing guerilla warfare; and each successive case must be so different from that which preceded it, in almost every particular which can be noticed, that little information can generally be derived from the perusal of such accounts. Having, however, been requested to give a description of what took place in the attack, by the Boers, of the small force under the command of Major Smith, of the 27th Regiment, at Port Natal, in May and June 1842, with the defence of the intrenched position, this short account is offered in the hope that there may be some points which may be found useful to officers who are likely to be employed in our colonies, or in countries similarly situated.

The extensive emigration of the South African Dutch farmers (Boers) from the colony of the Cape of Good Hope into the interior, in the years 1835 and 1836, not only deprived that colony of a most powerful body of men, who were at all times in readiness and accustomed to defend it from the aggressions of the native tribes, but at the same time spread disturbance and turmoil beyond the boundaries of the colony by their collision with the various races of the interior over all parts of that vast extent of territory, over which they quickly spread, and are now daily extending themselves, increasing in numbers in the same proportion that they decrease in all the habits and usages of a civilized life, and are fast retrograding to barbarism. At the time of their departure from the colony, the opinion was very generally entertained that they would be defeated and dispersed by the native tribes, and that the remnant would have to return for refuge within the colonial boundary. Instead of this being the case, they conquered, with little difficulty, the whole of the tribes with whom they came in contact. Some bodies of them settled down or led a roving life in the interior; others crossed the Kahlamba Mountains in the parallel of Natal, and, after defeating the Zoolah nation, settled in that district. Thus, instead of, as was predicted, being obliged to return into the colony, this people have ever since been a constant source of difficulty and embarrassment to the colonial government, by reason of their collision with the natives and their own condition.

The Boers, although not having any discipline or military organization, are yet accustomed to assemble and act together in large or small bodies, either to follow the Bushman or Caffre-robber on the spoor* of their cattle, or to attack native tribes,

* Track.

varying in number from 200 to as many as 30,000, or even 40,000 *, warriors. The Boer, indeed, now living in the western districts of the old colony, has, owing to the absence of the wild game, had little opportunity of exercising his love of hunting, and has thus, to a great degree, lost his useful qualities as a member of a warlike community; and in the late Caffre war these men were found miserably deficient in energy, activity, and courage, being, in consequence, in many instances, the derision of the Hottentot levies; but the Boer who has migrated into the interior is accustomed to constant wars with the natives, to hunting for his subsistence, and from his earliest infancy inured to hardship of all kinds, at least what by most other people is considered as hardship, but by them looked upon as a matter of every-day life. Their waggon, their home, a little coffee and bil-tong † supplying all their wants, living from their childhood in the saddle, and armed with their long guns, accustomed to fire at immense distances with an accuracy which constant practice alone can give, and to assemble together at a few hours' notice when summoned by their field cornets. Such were the people who had settled down in, and taken possession of, the territory of Natal; a people constituting a formidable enemy if resolutely headed.

In the year 1841 a large commando of the Boers having attacked a native chief ‡, it was considered necessary that a force should be stationed in the neighbourhood of the mouth and on the right bank of the Umzimonbri River. A party, consisting of a company of the 27th Regiment, a company of the Cape Mounted Riflemen, two light 6-pounders, with a detachment of Royal Artillery, and a few men of the Royal Sappers and Miners, were ordered from the frontier, and placed under the command of Captain Smith, of the 27th Regiment, who took up an admirable position on the Umgazi River, a small stream about ten miles to the south of the Umzimonbri. While the force remained in this position, no further aggression on either side disturbed the peace of the country; in the mean time some communications had been going on with the Colonial Government and the Boers at Natal. The latter had strongly and unhesitatingly asserted their wish and intention of remaining independent of the British Government, and said, if troops were sent up, they should oppose them by force. The company of the Cape Mounted Riflemen were withdrawn from the Umgazi; and in January 1842, 100 men of the 27th Regiment, with a few Artillerymen and Sappers, were sent up to the party at the Umgazi; and the force, consisting of 200 men of the 27th Regiment, two light 6-pounders and one 24-pound howitzer, 15 Artillerymen, 5 Sappers, and 6 of the Cape Mounted Riflemen, the only mounted men, were ordered on to Natal, leaving a detachment of 50 men of the 27th Regiment at the Umgazi. The knowledge in the colony respecting the position of the Boers at Natal was very limited. An erroneous opinion was entertained that the Boers had no horses, and that horses from the colony could not live in the Natal territory. The reverse was found to be the case, almost every Boer who mustered against the troops bringing with him his two or three horses and after rider, the horse sickness not more prevalent than in many parts of the old colony; but the Cape Corps being withdrawn, and the infantry alone sent on to Natal, was a most unfortunate circumstance, as the mounted

* The Zoolah nation musters about 40 regiments, of 1000 each, under one chief, Um Pandak. Another nation, the Amaswasi, were conquered by the Zoolahs in 1847, and incorporated with them, which is said to have increased their warriors to as many as 60,000. The Zoolah country is immediately to the north of Natal.

† Bil-tong, strips of meat slightly rubbed over with salt, and hung out in the sun to dry, will then keep for many months, and can be eaten without being cooked—an excellent substitute for salt meat.

‡ N'Capai, chief of the Amabaca. The Boers drove off 20,000 of his cattle without, as they themselves now acknowledge, any cause of quarrel with him.

Boer could, and did, always elude every movement that was made against him, whereas, if only a small mounted party had been present, the Boer could have been overtaken, and such an example at once made as would have intimidated them, made them at least hesitate before encountering the troops, and, on finding themselves liable to be individually overtaken and sabred, they would most probably have at once given up all thoughts of active resistance.

The camp at Umgazi received their supplies of stores, provisions, &c., overland, from the eastern frontier, the impracticability of the coast having deterred any of the coasters from endeavouring to land them at the mouth of the rivers, or along the coast: the supplies had therefore to be sent in bullock waggons from Graham's Town; and having to cross five large rivers, the Fish River, Keiskama, Kei, Umbashee, and Umtata, which remain full for weeks, and sometimes months, at a time, as well as numerous other smaller streams, great inconvenience was felt in the irregularity of the receipt of the supplies; and, at the time the force were ordered on, they were obliged to advance with only three months' provisions, in the expectation, however, of finding a vessel with supplies at the Bay of Natal. A few days before the troops were to march, "the Umzimonbri filled," and caused a detention of thirty days, so that the force did not leave their camp until the 31st March, having with them 70 wheeled carriages, to cross a country over which no waggon, excepting a solitary trader's, had ever traversed. The greatest difficulty was experienced in travelling over the marshy ground, which is worse near the sea, owing to the ground rising from the coast perpendicularly; the land immediately above receiving the drainage of the upper country without much fall on either side to carry it away, and an unusual quantity of rain having fallen, made this ground in a worse state than ordinary, and, although generally practicable for waggons, after a few had passed, it rendered the drifts over the small marshy rivulets, as well as larger streams, which are found every one or two miles all along the coast, so bad that the road had to be renewed after every one or two waggons had crossed. Several very steep hills had to be surmounted, and one, the Umterda Hill, over which the hunter and trader had never attempted to take his waggon, but always took it to pieces and carried it up or down. Up this hill, consisting of large boulders of granite, imbedded in what was then a swamp, a rough road was constructed; and by putting three spans of oxen, 36 bullocks, in each waggon, after three days' work all the waggons were got up. Constantly having to repair the road, cut through wood and bush, toil along the sand on the shore, and occasionally hook on and man the drag ropes for each waggon passing along "sideling" places, the force at length arrived at the Bay of Natal after a most harassing march of six weeks, having crossed 172 rivers and streams, encountered a great deal of violent rain, the men having often to sleep on marshy ground, no dry spot being able to be found for the camp. In a few instances the Caffre guides mistook the road, but generally were found to be correct, and to have a good idea of the spot where a waggon could travel, or rather where it could be forced along.

The troops arrived at the Bay of Natal on the 3rd of May, and encamped at the head of the bay. The position is a difficult one for a small force to occupy, to secure the important and all-necessary objects of giving protection to the town, communication with the landing-place, and at the same time hold a defensible position. The nature of the ground is such that no single site will secure these objects. The ground in the neighbourhood of the bay is covered with wood, large trees with dense undergrowth, almost impenetrable in many places; a range of hills (the Berea Hills), thickly wooded, runs parallel to the coast at about one and a half mile distant; to the north of the bay an accumulation of sand-hills forms a barrier between the sea and land.

Between the sand-hills and the Berea Hills extends a flat called the Itafa Amalinda, covered with detached clumps of bush, varying in size, which, with the rich grass and luxurious foliage, gives a peculiarly beautiful park-like appearance to the scenery. This flat is bounded by the bay, and the Umgeni River at each end. On the bay side were built the huts and houses forming the village of Port Natal. The channel runs too far off to enable vessels to land at the town, so that all goods are obliged to be landed at the extremity of the tongue of land formed by the above-mentioned sand-hills. To the south of the bay the ground rises precipitously 190 feet high from the sea, and forms a bluff point extending outside the sandy spit, the channel running between these two tongues of land, before the water spreading out forms the bay. Thus there could be found few situations more difficult for a small force to occupy in a defensible position. The point, the landing place, is in itself wholly untenable. Had the troops taken up their position there, they would not have been able to have maintained themselves a week against the Boers who attacked them. The bluff is isolated, of no use to the town, and does not give by itself any hold in the country. The position at the head of the bay was bad, being too far from water and surrounded with bush. The flat on which the town stands was then the only position available; and to it the encampment was moved, about three quarters of a mile from the huts of the settlers.

As mentioned above, the Boers had asserted their intention of opposing by force the occupation of Natal, and, hearing that the troops were likely to move on from the Umgazi, had sent a small commando down the coast. This party returned before the troops arrived. Some Englishmen, who had been long residents in that part of the country, and had been living among the natives, and were looked up to by them as chiefs, had ordered the approach of the troops to be kept a secret from the Boers. This order was implicitly obeyed; and although the force was detained for five days at the Umcumas, a large river only 30 miles from the bay, the first intelligence the Boers had of the approach of the troops was their winding down the hill above the first Boer's farm, about 14 miles from the bay. Amusing was the consternation at this farm at the sight of the red coats; women running about screeching, the men and servants catching the horses, saddling up and riding on the road to Pieter Maritzburg, to announce the unwelcome intelligence that the hated Englishmen had come, unwelcome to almost, but not quite, all. There were a few who even then foresaw the quarrels breeding among themselves, and dreaded each other more even than the rule of the British government. If the Boers had been aware of the troops' advance, and, as was their intention, gone out against them in their overwhelming numbers, it may with confidence be asserted that scarcely a man would have reached Port Natal. In the first place the Caffre guides would have deserted on the first shot being fired, and the 200 infantry, with a long train of bullock waggons and three guns to protect, covering a space of generally little less than two miles, toiling over an unknown, roadless country, interspersed with bush and broken ground, would have been picked off, man after man, by the mounted Boer, without any opportunity of returning the fire of the Boer, who would not in any way expose himself. The natives, however, having carefully concealed the approach of the troops, they marched into the village of Port Natal without the Boers being aware of it in sufficient time to muster to oppose them on the march.

A protest presented by the field cornet against the approach of the troops, to Major Smith, was the only overt act of hostility taken by the Boers at first. The only ground available for an intrenched position appeared, after a minute reconnoissance of the country, to be the spot mentioned above, marked B on the accompanying sketch, No. 1. This site offered the advantages of a tolerably clear sweep all round, and, above all, was well supplied with water, both from the marsh and from a well which was immediately sunk inside the camp. In this position the troops encamped, on a slightly elevated piece of ground, drawing up the waggons between three clumps of bush, which, after being cut down, served for an elevated platform for the guns, to flank the waggons and protect the encampment. The tents were pitched in the interior space, and preparations were commenced for collecting materials for hutting the men, intrenching the position, and constructing a redoubt to preserve the communication with the port and village, the whole of the waggons having to be sent back to the colony by the same route as soon as possible. In the mean time, however, the Boers began to assemble at the Congella, about four miles distant from the camp, and day after day brought great numbers of them from the interior. About a month before the arrival of the troops, Port Natal had been visited by a Dutch vessel from Holland. The captain and super-cargo, to answer their own purposes, to obtain a more ready sale for their goods, had encouraged the Boers in their idea of establishing an independent government and of resisting the troops, so that the minds of these ignorant people were more than ever excited. They believed the story that they would receive assistance from Holland, and so were resolved to resist the occupation of the country by Her Majesty's Forces. Very little information could be obtained of their proceedings at the Congella; but it was generally, at first, supposed that they would quarrel amongst each other and disperse. In a few days, however, their commandant, Pretorius, posted a notice desiring the troops to quit the territory of Natal. Major Smith had this notice pulled down, and then Pretorius assured him that the Boers would disperse quietly, that it was a small party only who were ill-disposed, and that the rest would get the upper hand and all would be quiet. Major Smith, anxious to give them every chance of dispersing quietly, and to avoid collision as long as possible, did not, relying on the assurances of Pretorius, march to the Congella to disperse them, as might have been easily done at that time, when they had not mustered in the numbers they subsequently did. The troops were badly off for provisions when they marched into Port Natal, having only a few days' supply. One or two more was, however, very fortunately, immediately procured from a store in the village, and about fourteen days', a short time after, from the brig "Pilot," despatched from Cape Town with two iron 18-pounder guns, stores, and supplies. On the morning of the 22nd of May the Boers mustered in large numbers on the edge of the bush round the camp, galloped down upon the plain, and swept off a considerable number of the cattle grazing under the camp, the herdsmen being driven away. A party, instantly sent from the camp, succeeded in recapturing some of the cattle. A few distant shots passed between them and the Boers. This was the first commencement of hostilities. A notice was handed to Major Smith from the Volkoraad, desiring the troops to quit the territory, which was returned to them.

The Boers having thus openly placed themselves in rebellion, it became necessary to take some steps to assert Her Majesty's Authority, requisite for the troops to take measures to disperse the rebels; no reinforcements could be received from the colony before, at the very shortest time, five weeks, and it was evident that before that time something must be done, some endeavour must be made to put down the rebellion. A force of 50 men had been left at the Umgazi, but it was impossible to order them up, as they could never have passed through the country now occupied by the Boers.

It was, therefore, of primary and immediate importance that the Boers, assembled at their "lager" at Congella, should be dispersed; the want of cavalry crippled every manœuvre we could make against them; whenever the infantry moved out of the camp, the mounted Boer concealed in the bush, or taking advantage of the slightest cover the ground afforded, which, from constant practice in hunting the wild game, they well understand, galloped up in numbers from all points, and, after firing, retired, and advanced again at the gallop for another shot; thus there was no chance of overtaking the Boer, so that it was decided by Major Smith to advance against the Congella at night; and on the night of the 23rd of May, 1842, a force * consisting of 100 men of the 27th Regiment, two light six-pounder guns, with 12 artillerymen and 5 sappers †, were ordered to march from the camp at 10 P.M. A boat had been fitted up with a 24-pounder howitzer that morning, and was ordered to drop down the channel, and, on a given signal, open its fire upon the Congella. It was hoped that the Boers would have been taken by surprise, and have been dispersed without firing upon their camp. From the information received it appeared they were in the habit of keeping a party stationed in the bush between the camp and Congella; but that by marching over the sands the force would be able to reach the Boers' "lager" without their being aware of it, and it was calculated, and the pilot affirmed, could do so without being ankle deep in water. The force accordingly left the camp at 10 P.M. on the night of the 23rd of May, a bright moonlight night, under the command of Major Smith, and had advanced within about 800 yards of the Congella, when the Boers, who had received information of their approach, and concealed themselves in the mangroves at the edge of the bay, just at the point where the troops must come within musket shot before advancing on the Congella from the sands, opened their fire upon them by a single musket shot instantly followed by a volley which killed and wounded many of the gun oxen, which rushed among the troops and caused considerable confusion; the boat with the howitzer, which had been ordered to drop down the channel, and on the signal being given open its fire upon the Congella, by mismanagement got aground, and thus did not take up its proper position; but on the firing commencing opened its fire, the shot falling just in rear of the troops; had the boat dropped into its right position, the Boers could not have taken their post in ambuscade against the troops. The guns came into action, and the infantry returned the fire of the Boers; but, as it was impossible to take the guns with us in advancing against the Boers, and by advancing we should have placed the Boers between us and the camp, Major Smith ordered the retreat, being obliged to leave the two guns behind, not having the means of taking them back to the camp, the oxen being shot or wounded, and perfectly unmanageable. The troops had only reached their camp a few minutes when the Boers surrounded it on all sides, and kept up an incessant fire for about two hours, until daybreak, and then retired. The casualty on the side of the troops at the attack upon the Congella was as under:—

	Killed.	Wounded.
Royal Artillery . . .	1 Officer and 4 N. C. O. and R. and F.	2 N. C. O. R. and F.
Royal Sappers and Miners	,, ,,	2 ditto ditto.
27th Regiment . . .	,, 16 ditto ditto	2 Officers 26
Cape Mounted Riflemen	,, 1 ditto ditto	

Lieutenant Wyatt, R. A., Capt. Lonsdale, Lieutenant Tunnard, 27th Regiment.

* Under Major Smith, 27th Regiment.
Captain Lonsdale, Lieutenant Tunnard, Lieutenant Molesworth, } 27th Regiment.
Lieutenant Wyatt, Royal Artillery.
Lieutenant Gibb, Royal Engineers.
Lieutenant Irwin, 27th Regiment, being left in command of the camp.

† Under an officer of the corps of Royal Engineers (the author of this paper), who acted as an assistant Quartermaster-General on the march, and aide-de-camp to the commanding officer.—EDITORS.

During the Boers' attack upon the camp the smoke hung over the ground so much from the incessant firing, that nothing could be distinguished but the flash of the guns. A waggon-driver was shot by a Boer who rode up close to one of the sentries, and on being challenged fired at the man and killed the driver at his waggon; three other men were wounded inside the camp. The loss on the Boers' side was greater, being the only time they exposed themselves during the whole operation.

A few days previously the *Pilot*, a merchant brig, arrived from Cape Town bringing two 18-pounder guns and stores; it is much to be regretted that they were not sent up in an armed vessel. An officer and 25 men had been detached to the Point to guard these stores; the officer had to be removed to take charge of the camp, when the force marched to the Congella, and the party was left in charge of a sergeant. At daybreak of the 24th, the Boers surrounded it on all sides, shot the sentry; the men defended the stone building, which they occupied as a barrack, for some time with gallantry, but on the Boers taking the whole Point, and the two merchant vessels, surrendered.

The troops were now confined to their camp, and the Boers mustering, as it was afterwards ascertained, upwards of 1200 men, surrounded it on all sides. To the 26th of May they were making preparations for an attack, which they imagined was to be successful in driving the Englishmen out of the country. By the pillage of the vessels and stores at the Bay, they obtained a further supply of gunpowder in addition to the large quantity which is always found among them. An 18-pounder gun and the two 6-pounder guns taken by them at the Congella, besides about six of their own guns, were brought against the camp; they made a number of leaden balls for these guns by running lead round an iron bolt in a hole made in the ground, as near the size of the ball as they could make it; these being completed, and their men told off under their respective field-cornets and commandants, they were ready for the attack on the camp on the morning of the 26th of May. On the 24th a truce had been agreed upon for the exchange of dead and wounded; our poor fellows were buried on the morning of the 26th. Several messengers were sent by them desiring the troops would leave the country, and then the truce declared to be at an end. In the mean time a special horseman had been sent by Major Smith to the colony, and the troops arduously employed strengthening the camp, and constructing a large kraal of stakes and abbatis for the protection of our cattle, the horses being picketed inside the camp. The waggons were drawn closer in, and a trench dug on the inside, the earth being thrown up under the body of the waggon, which was thus embedded in the parapet; the musketry fired over the parapet underneath the bed of the waggons. The guns, 18-pounder and 24-pounder howitzers, were placed in batteries at two opposite angles. The soil being an easy sand, the work was completed by all hands working by reliefs night and day; traverses were left in the line of trench to protect from enfilade, and the earth thrown up in rear of trench to protect from reverse fire, and from the leaden shot dropping into centre of the camp.

On the morning of the 31st May the Boers opened their fire upon the camp by a shot from their battery; the cannonade was kept up all this day, and with more or less vigour every day and night until the relief arrived on the 26th June, from their batteries.

The leaden shot generally smashing through the waggons, or over them among the tents in centre of camp, did but little damage beyond injuring the waggons and tents; they threw in all about 950 shots into the camp. Their musketry fire was generally kept up night and day. Their trench approaches to the camp executed as shown in the sketch; those nearest to the camp being loopholed with sand-bags, from which they could pick off any one exposing himself in the camp; the trenches commencing from ground which they could approach under cover without being exposed to the fire from the camp, and at these points they kept their horses, in readiness to mount, so that on any movement being made from the camp they fired, and retiring along the trench to their horses, speedily got out of reach, while the remainder of the Boers riding up from other points to their support frustrated every endeavour of the troops to attack them with success and without immense loss. The trench A No. 2, was attacked by a party under Lieutenant Irwin, 27th Regiment, on the night of the 8th June; the Boers retreated from it, and the trench was filled up. The trench H No. 2, was also attacked on the night of the 18th June by a party under Lieutenant Molesworth, 27th Regiment, and, after a struggle, some Boers bayonetted in it: we had to regret the loss of Ensign Prior, 27th Regiment, and 3 men killed and 4 wounded; it had the effect, however, of preventing the Boers in future approaching so close to the camp. Some admirable practice was made * from our guns by a bombardier of Artillery. Provisions in the camp were getting scarce, the troops were put on the smallest allowance possible, the horses killed and made into bil-tong, and issued with the remnant of the beef bil-tong, the oats ground and served out every other day in lieu of meal and biscuit, and by thus eking out to the utmost, the provisions could have been made to last for another fourteen days beyond the period of the relief.

The sole chance of any information being received in the colony of the state of affairs at Natal depended upon the safe arrival of the special horseman despatched on the 25th May; this messenger was an English settler resident at the Bay of Natal, accustomed to the natives and to the country; he started with a led horse, swam over to the Bluff Point, and got safely by all the Commandos of the Boers who were scouring that part of the country, through the frontier and other Caffre tribes, across the rivers, &c., and arrived on the fifth day at Graham's Town. Colonel Hare, the Lieutenant-Governor, immediately ordered the Grenadier Company of the 27th Regiment, under Captain Durnford, with an officer and a few men of the Royal Artillery, to embark in a small schooner (the *Conch*) from Port Elizabeth for Port Natal. On the information being received at Cape Town by the Governor, Sir George Napier, H. M. S. *Southampton*, the admiral's flag-ship, with four companies of the 25th Regiment, under Colonel Cloete, was despatched immediately. The *Conch* arrived a few days before the *Southampton*, and Captain Durnford communicated with the Boers, who refused all intercourse with the camp, or to allow a surgeon to be sent there; the force in the *Conch* was too weak to effect a landing. On the *Southampton's* arrival in the outer bay, the landing was ordered for the following morning, viz., the 26th June.

On this morning, there scarcely being a breath of wind, the boats of the frigate were ordered to tow the *Conch* across the bar and up the channel into the inner bay, the boats and *Conch* being full of troops, when, very fortunately, or the casualties would have been greater, as the boats would have been so much longer exposed to the fire of the Boers, a fair breeze sprung up, the schooner took the boats in tow, and all made rapid progress into the bay under a heavy but ill-directed fire from the Boers from the Bluff and Point. The Boers retreated on the troops landing, having left in haste, and with some loss, their trenches round the camp, and retired up the country.

Colonel Cloete in a short time managed to effect a pacification with them, and subsequent events have shown that it is very much to be deplored tha some of the ring-

* Bombardier Porter, R.A., who, on one occasion, destroyed the carriage of the Boer's gun, killed the Boer who was sitting on the limber-box, and dismounted the gun; and at all times laid the 18-pounder gun, of which he had charge, with admirable precision. This man's coolness and general usefulness was the admiration of all.

leaders were not punished for their rebellion at once; leniency being looked upon by them as weakness; and they have never since left off fomenting disturbance both within and beyond the boundary of the colony, whereas then they were disheartened and fearful of the punishment which they at that time thought was justly due for their rebellion. If a few had been made an example of, and then an unconditional pardon extended to the rest, it is generally supposed that it would have had a salutary effect upon the whole, and gone far towards making them a more settled people.

From the above encounter with the Boers, the following would seem to be more particularly deduced:—

1. That guns drawn by oxen should never be used as field artillery, where they are required to perform movements in action under an enemy's fire.

2. The want of a small body of cavalry entirely crippled every movement. Had there been thirty mounted men, the force would, most probably, never have been shut up in the camp, but would have been able to take at once the offensive with every probability of success.

3. The necessity of practising the infantry soldier more frequently in the use of his musket with ball cartridge, more particularly in countries like the Cape, where he has so often to trust to his own individual correctness of aim and knowledge of his weapon, and has so little need of the ordinary evolutions *en masse.*

Notes on the Settlement of Natal.

The colony of Natal, unsurpassed and perhaps unequalled by any of our colonial possessions for salubrity of climate and fertility of soil, is situated on the eastern coast of S. Africa, between the 27° and 31° parallels of S. latitude; bounded on the E. by the Indian Ocean, on the W. by the Kahlamba or Drāākberg mountains, containing an extent of territory of about 13,000 square miles.

In the year 1836 numerous bodies of the Dutch emigrant farmers (Boers), in their migration from the colony of the Cape of Good Hope, journeying from the interior up the gradual ascent of the Kahlamba, reached the summit, whence the chain breaks off precipitously, and from it looked down upon the territory now comprising the district of Natal. Into this territory, which was then inhabited by remnants of scattered native tribes, who had survived the desolating wars, the wholesale slaughters of the Zoolah chief, Chaka, the emigrant Boers descended, and, after defeating the Zoolah nation under Dingaan, established themselves; and being joined from time to time by considerable numbers of their countrymen, who flocked, both from the old colony and from their wanderings in the wilds of the interior, to their brethren located in this new and fine country, proceeded to form a government of their own there, laid out a town, Pietermaritzburg, as their capital, on a well-selected site, 65 miles distant from the Port of Natal, apportioned out the land, allotting a farm of 6,000 acres to each head of a family, elected a Volksraad, made rules for the future administration of the government of their intended republic, &c.

In a short time, however, the complaints of the natives drew the attention of the Colonial Government to the proceedings of their subjects, who had thus migrated from their immediate jurisdiction, and were establishing a government of their own in a country recognised as a portion of Her Majesty's dominions; and in 1839 a Company of the 72nd Regiment was sent by sea from Cape Town to Port Natal. This force encamped at the Point and took military possession of the harbour, but no cognizance of the internal affairs of the Boers: it was withdrawn after remaining there a year. In January, 1841, a large commando of the Boers having attacked and plundered a native chief in alliance with the Colonial Government, a force under command of Captain (now Major) Smith, of the 27th Regiment, was ordered to the right bank of the Umzimvubu, or St. John's River, about half way between the eastern frontier and Natal. In the following year the force was ordered up to take possession of Natal, and proclaim Her Majesty's Authority over the territory. They arrived there in May, 1842, and were immediately attacked by a large force of the Boers, and it was not until a reinforcement was sent by sea from Cape Town, which rendered further resistance impracticable, that they submitted *. From this period until August, 1845, the management of this portion of Southern Africa was entrusted to Major Smith (then of the 27th Regiment) as Commandant of Natal; and to his superior ability, firmness, and unerring judgment, is due the maintenance of peace during that time, the name of Major Smith being now remembered with esteem and regard by the Boer and the native inhabiting that region of Southern Africa. In December, 1845, a Lieutenant-Governor, Martin West, Esq., with the usual functionaries for the establishment of a civil government, arrived; and head-quarters, both civil and military, were established at Pietermaritzburg, the spot admirably chosen by the Boers as their intended capital.

The position of the district in regard to its inhabitants was peculiar, containing within it three races of people so different in their feelings, manners, and habits, the English settler, the Boer, and the Native (Zoolah Caffre). The English consisted of traders residing in the towns of Pietermaritzburg and Port Natal, a few small farmers in the neighbourhood of these places, and the members of the government. The Boers were chiefly scattered over the country on their farms, many of them on the occupation of the district by the troops had reascended the Kahlamba range, and sought the interior, where they could live, unshackled by any law, free from all the restraint imposed by a civilized government; this migration continued until at the end of the year 1847 very few remained within the bounds prescribed as the district of Natal, and as such under the immediate sway of the local government. On the other hand, the number of the natives, which was at first estimated with tolerable accuracy at 100,000, was constantly augmenting, by fugitives from the surrounding tribes fleeing into the British territory from the tyranny and despotic rule of their own chiefs, to seek the protection of the government; nor were the local authorities, however desirous to do so, able to stop this migration, although discouraging it as far as possible, because compelling the fugitive to return to his own country was devoting him and his family to certain death. Such were the inhabitants of Natal, so different in their views and customs, and surrounded on all sides by independent native tribes, whose sole thoughts, both as a nation and as individuals, are devoted to war and its, to them, natural sequence, plunder, from their earliest youth. Immediately over the northern boundary reside the Zoolah nation, mustering an army of 60,000 warriors, under one despotic chief, Um Pandah; and on the other sides smaller tribes more or less powerful and numerous. Although these tribes were in communication with the Caffres on the frontier of the old colony, with whom the war was being carried on, and the large military force, and its inhabitants formed into a burgher force, were actively engaged in its protection, and they constantly heard from them of the large herds of cattle captured from the white people, yet, during all this time not a shot was fired in anger at Natal, with the exception of one expedition against a petty

* The operations connected therewith being described in the foregoing part of this Paper.

refractory native chief; and it may with some confidence be affirmed, that, had it not been for the position held at Natal, not so much by reason of our strength in regular troops,—which was confessedly almost hazardously small in the then situation of affairs, consisting only of the head quarters 1st Battalion, 45th Regiment, with Detachments of the R. A., R. S. and M., and Cape Mounted Riflemen,—as by the moral influence possessed in that region, the dependence upon us of the native subjects within our boundary, the knowledge to the independent tribes, that upwards of 120,000 souls, about 20,000 of whom were capable of bearing arms, were under our government, and would be headed and led on by the white man, and then be a very formidable enemy to them, the whole of the native tribes inhabiting this portion, extending from Delago Bay southwards, would most probably, more or less, have assisted the frontier Caffres in pouring into the old colony; thus, had it not been for our settlement at Natal, the old colony would very likely have had to contend against the large force of perhaps 60,000 Zoolahs, and the Amapondahs, mustering not less than 15,000, besides other smaller tribes, in addition to the frontier tribes.

So much had this influence extended, that it would have been possible, if affairs on the eastern frontier had rendered it necessary, to have marched a body of 10,000 natives, headed by white men, and supported by a regular force, to the rear of the frontier tribes to the assistance of the old colony. It was, however, for many and obvious reasons, very desirous not to have recourse to this measure, except in a case of extreme emergency.

It became then one of the first objects of the Lieutenant-Governor on his arrival at Natal, to cause such tracts of country to be allotted for the use of the scattered tribes as would be sufficient for them, and which might, with equal justice to their interests and that of the Europeans, be appropriated for their use; a commission was appointed by him to report upon this subject. The unsettled state of the whole of Southern Africa at this period, and various causes, combined to delay the settlement of this question, and delay involved it in more difficulties: before giving a short outline of the system proposed for its adjustment, I proceed to make a few remarks upon the various claims to land, and the state of that question, in order to a clearer view of the subject.

As mentioned above, the Boers on their arrival in the country apportioned out the land into farms, each person receiving a grant of one from the Volksraad; many of these farms were immediately occupied and cultivated; on some of them a portion of the scattered native tribes were residing: this was the case, however, with but few which were actually under cultivation, although some grants of land had been made by the Volksraad, to which the natives laid claim, on the ground of occupation before the arrival of the Boers, and in some instances as the original land of their forefathers, the hereditary dwelling-place of their tribe. Prior to the establishment of a regular government, a special commissioner had been sent to Natal to report, for the information of Her Majesty's government, upon the claims to land; but as the instruction directed the registration of only such lands claimed by the Boers as had been *bonâ fide* occupied, and this occupation not being compatible with the circumstances in which the country had been placed, giving to some large tracts of land, and wholly excluding others, who had in their eyes an equal title, this unhappily involved the land question in more difficulties, and became a cause of real dissatisfaction to the Boer, as well as a constant source for an alleged grievance. The Natal territory being proclaimed under the immediate jurisdiction of the British crown, upwards of 100,000 natives found themselves British subjects, being residents within the assigned limits of the district; it was therefore of vital importance that the boundary of their land should be defined as soon as possible, in order that it might be kept distinct from that to be assigned to the colonists, and their government, as far as is compatible with the principles of justice, made to assimilate to their own laws and customs.

The following is an outline of the proposed scheme, which it was conceived would alike promote the prosperity of the white colonist; meet the present wishes of the native, and tend to his advancement intellectually and morally, opening a fine field for the missionary and schoolmaster to inculcate the principles of religion, the softening influences of civilization; the admixture of the two classes, and the prevention of one of them feeling in the condition of an inferior being to the other, of an irretrievably degraded caste; and, while obtaining these advantages, and their consequence, the future well-being of the colony, provide the securest means of protection to the settlement, whether from aggression from without, or from disturbance within, its boundaries.

1. In order that the ground of the colonist and native may be kept distinct, tracts of land to be assigned for the use of the natives at the rate of about 20 acres to each individual, or 32 persons to each square mile; these portions of country to be called "Native locations," and as such to be placed under different rules and regulations from those of the remainder of the colony, to contain about 10,000 inhabitants each, apart from each other, and selected in reference to nature of ground, and, as far as possible, to their own preferences, prejudices of particular tribes, the claims and superior capabilities of soil for residences of white inhabitants, &c., &c.

2. The native portion of the community thus having ground allotted to them, and distributed in about ten different settlements, each containing an area averaging about 340 square miles, the remaining portion of the colony to be divided into districts or magistracies, and central sites selected in each for their fertility and general capabilities, and laid out as towns or villages, with a church, school, magistrates' offices, &c., and a cattle kraal erected on each, the whole inclosed and made defensible, or so placed as to be easily made so; thus would be formed a rallying point for the inhabitants of each division, a secure place for their families and property in time of need, and general confidence be inspired in the minds of all.

3. For the management of the native locations, a resident officer of the government to be appointed over each, as "Superintendant of the Location," to administer its internal affairs, subordinate to, and reporting periodically to the agent for the natives at head quarters, deciding all cases of dispute among them, making a careful registration of all the inhabitants, men, women, and children, and of all live stock; and, while ruling them at first according to their own laws and usages, as far as is compatible with equal justice to all, and summarily deciding all matters of trivial import, and, in cases not affecting the lives of the accused endeavouring gradually to set them aside in favour of ours, and to instil into their minds the superiority of them and of our customs to their own; giving all encouragement to the missionary and schoolmaster, and to every attempt to elevate their women in the scale of society, to a generally more advanced style of living and cultivation of the ground than now obtains among them. A body of native policemen to be formed immediately, which would in ordinary times aid in the internal administration of the government of the location, and in case of war be a nucleus upon which the whole strength of the settlement might be gathered, either for its own internal protection or for the general defence of the district.

4. It has always been found that a considerable number of natives congregate around the towns in various capacities, and in this position, being left without control, they have been a source of annoyance to the town, and rapidly become degraded. To provide for these people, a piece of ground to be allotted in the immediate vicinity

of each of the principal towns inhabited by the colonists, and their management when thus residing to be taken under the immediate surveillance of the diplomatic agent.

Such is the general outline of the system, to the carrying out of which the more intelligent and enlightened of the colonists look with some confidence to gradually making the colony of Natal become one of the most flourishing, as it is at present one of the most fertile, of the colonies; and, although many obstacles exist, and difficulties would no doubt have to be surmounted, and prejudices overcome, before it could be brought into universal operation, yet much combines to afford the hope that it can and will be adopted, and that it will have the anticipated and desired effect.

In the first place, the position, circumstances, and character of the natives themselves is favourable to its adoption and gives promise of success. Having been accustomed to war and bloodshed from their earliest infancy, and to being driven from place to place by the Zoolahs, a sense of the security and prosperity they now, as a people, enjoy under the protection of our government, very generally obtains among them. Their individnal condition affords to each a still greater contrast, accustomed from their childhood to the despotic and arbitrary rule of their chief, liable at any moment for any trifling offence, or even an alleged one, or suspicion of witchcraft, to be deprived of their lives and property, they now find themselves free from this tyranny, and indeed almost entirely without restraint, as the power of their own chiefs, except in petty cases, has been set aside by their becoming British subjects, and as yet no local authority has been placed over them in its stead; their whole management having been entrusted to the diplomatic agent, Thomas Shepstone, Esq.; and to his judicious arrangement, admirable tact, and ability is to be attributed the devotion which they now show to the government, and the peace preserved among them. It is obvious, however, that upwards of 120,000 natives scattered over such a tract of country cannot be managed efficiently by one person, and the immediate appointment of a "superintendent," or "agent," over each location has been strongly urged. They are accustomed to render the most servile obedience to their chief, to regularly constituted authority, placing the most implicit confidence in him; and this confidence they are disposed to place in the officer appointed over them by the British government. It is of the highest importance that this officer should be nominated at once, as their disposition in this respect is liable to alter to perhaps worse and dangerous views of self-independence, from the entire relaxation of wholesome local restraint over them. They have no wish to be independent, being aware that their very existence depends upon their being under the protection of the British government, and they are anxious to have a European resident among them, to whom to refer their disputes, punish them when wrong, protect them when right, &c., and, above all, although in general willing to remove to any land the government shall assign to them, yet they are anxious for some land to be guaranteed to them as their own, so that they may feel themselves secure upon it. Each individual is considered a warrior from his youth, and is eager to distinguish himself as such, and, as they fight with great confidence when headed by a white man, they would willingly rally round their superintendent should any emergency require it.

The very knowledge to the tribes beyond the boundary of the formation of these settlements, and of the inhabitants being headed by a white man in war, would have the effect of deterring them from any inroad into the colony, or of assuming a position hostile to it. Some of them have already been brought under the influence of religion, and the younger portion of them are very eager for instruction in reading, writing, &c., as well as in all the arts of civilized life. They who are cognizant with the tribes called " Frontier Caffres," will recognise the difference existing in their character and that of the Zoolah inhabiting the district of Natal, thus slightly sketched.

The advantage of locating them in separate bodies, interspersed among the white population, appears as obvious as considerable, preventing all chance of any combination against the government, if it should be unhappily ever necessary to enforce a measure generally displeasing to them, and which would thus unite their sympathies. Of this, however, there will perhaps be little likelihood, as they still keep up the remembrance of the feuds which of old existed between their tribes; and some difficulty has been experienced in consequence, where it became necessary to locate them in the vicinity of each other. The probability of their becoming cattle-stealers, one of the chief things to be guarded against, and which has been the great bane of the eastern districts of the Cape of Good Hope, and to which every native in South Africa is more or less liable, and, if they have great temptation, almost impossible to resist, is, by this system, much lessened, as they would be sure of instant detection. They are accustomed to the idea of taxation, and advantages would be gained by its being required from them, independently of the amount realized to the treasury of the colony, as they would more forcibly and directly feel that they were British subjects, and, as such, under the protection and fostering rule of our government. A sufficient amount, it is apprehended, could be collected from them to furnish a surplus to the general revenue of the colony, after defraying the expense of their own government. Some trouble would be experienced at first in its collection, and in the more distant parts of the colony it would be necessary to allow them to pay in produce, at least until money obtains a more general circulation among them.

Secondly. The colony is well watered, a stream flowing through every valley, a spring or stream found in the highest land, and the surface, in almost every part, presents a country capable of sustaining a dense population, and, when the natives are brought under the wholesome restraint which this scheme proposes, will offer to the Boer and European colonist, with the advantages of a fertile soil and salubrious clime, a land secure of peace within itself and with the adjacent tribes; and, by laying out their villages and farms in such situations, and on such a plan, as to be easily defensible, the whole would prosper, and, by the feeling of security it would engender, enable the inhabitants to turn their whole attention to the cultivation of the soil, in which they are already making some progress, especially in the growth of cotton, which thrives remarkably well in the neighbourhood of the port and along the sea coast, the settlers expecting to be able to freight a small vessel to Liverpool this year with the produce from their cotton plantations.

By this arrangement the regular troops would be able to be kept concentrated in one or two central positions in the colony, in readiness at all times, in the event of war or of any outbreak arising, to be immediately marched in force to any point, either to a native location, or to a village or settlement of the colonist, as the case might require. This concentration would add to the moral effect of the presence of the troops, which has unfortunately, in the present state of affairs in colonies similarly situated, been too often, although unavoidably, weakened by being detached in too small parties.

The state of preparation thus educed would be likely to insure these very preparations not being requisite, and thus hasten the attainment of the object to be looked for, viz., the preservation of tranquillity and peace, and, in consequence, the maintenance of order in the infant settlement, the prospect of progress in its institutions, and the speedy development of all its resources.

Before concluding this paper, it will be necessary, for a clear view of the state of the district, to advert to the position of the Dutch emigrant farmers in that portion of

South Africa. The fact of their having again receded from the immediate influence of British jurisdiction, from the district of Natal into the wilds of the interior, has been mentioned above. This migration left the district, at the end of the year 1847, almost entirely destitute of a white population; and a few of the more ill disposed among them having endeavoured to induce the Zoolah chief to an inroad into the colony, in conjunction with them, great alarm prevailed among the remaining colonists, Dutch and English. At this crisis the approach of Sir Harry Smith to visit Natal, *viâ* the interior, was announced; and reliance on him speedily dispersed the panic that had spread, and restored general confidence. The appointment of Lieutenant-General Sir Harry Smith to be Governor and High Commissioner of the Cape of Good Hope and its dependencies, &c., &c., was hailed by all the colonists with universal joy, and with the firm assurance that the distracted affairs of Southern Africa would soon be placed on a firm footing, if such were a possibility. Fully have their anticipations up to this time been realized, as well by the terror and respect which the frontier Caffre still entertains for the name of Colonel Smith, as by the untiring energy of body and mind, and comprehensive grasping of the whole affairs of South Africa by Sir Harry Smith himself. In December, 1847, he landed at Cape Town, immediately proceeded to the frontier; the whole of the chiefs submitted, and matters there were placed in training for final adjustment. He then started, without escort or retinue, for the interior, to visit the Boers who had migrated from our dominions; thence to visit Natal, where he arrived in the beginning of February, 1848, having, before he reached Cape Town again, travelled over upwards of 2000 miles of country, crossing swollen rivers, and overcoming other obstacles, which they only can fully appreciate who have journeyed in this or a country similarly destitute of the usual resources and necessaries of life. The Boers in the interior having voluntarily cut themselves off from religion and civilization, are, as might be expected, fast retrograding to barbarism, their children growing up in perfect and complete ignorance, their families very often only covered with a few skins. Sir Harry Smith, in his journey, having seen numbers of these unfortunate people, heard all their statements, &c., endeavoured to do all in his power to induce them to return within the pale of British jurisdiction, to bring them once more under the influences of good which they had thus debarred themselves. The condition, feelings, and nature of these people would be foreign to the purport, and occupy too much of this already lengthened paper. It will suffice to say, that Sir Harry immediately saw the incompatibility of the mode prescribed for granting land to them within the district of Natal, and immediately on his arrival at Pietermaritzburg issued a proclamation offering a farm to any one who had claim to land, provided he asserted such claim within one year to a land commission then established by him. It is more than probable that, if such a method had been resorted to at first, many of these people would still be found within the limits of the district of Natal; and still, although it was reported that some designing persons were endeavouring to pervert the meaning of the proclamation, to misinterpret Sir Harry's address to them, it was with some confidence expected that many of them would, notwithstanding their numerous and deeply rooted prejudices, accept the offer so liberally made to them. Thus the great object would be attained of rescuing this people from a state already verging on semi-barbarous, and restoring them to the colony.

The vast expense incurred in the war with the frontier tribes on the eastern province of the Cape of Good Hope; the call upon the resources, in troops and specie, of the mother country; the loss to the colonists themselves, would appear to call upon the exertion and forethought of every one connected with this and similarly situated countries, to devise and do their utmost to work out such a plan as to prevent, as far as possible, such contingencies for the future, by being in a better state of preparation to ward off or meet a like emergency. It would seem that any scheme for the settlement of any new, or the improvement of any old colony, must assume, as its basis, a systematic system of apportioning the land to the colonists, by laying out their towns, villages, and settlements, with due regard to rendering them defensible, by selecting for them some spot which would offer a secure rallying point to the adjacent inhabitants, a safe retreat for their herds and cattle, and stores for their produce, as far as practicable; and, above all, every endeavour being made to impress upon the minds of all the colonists, of whatever grade or colour, that they must be prepared to defend themselves, their families, and property, more especially when resident on the borders, in the vicinity of a savage race, of a people whose sole thoughts are devoted to war, whose almost entire aim of life, in their barbarous state, is the acquisition of cattle; and when they see in the immediate neighbourhood large herds, difficult indeed will be the entire suppression of all cases of theft; and if the savage sees he can, with probability of immediate success, make an irruption on a large scale, most assuredly he will not lose the opportunity.

The colonist hitherto has been in the habit of considering his protection as a matter with which he, personally, had little to do, and almost entirely looked to the regular troops, both for protection against petty aggression and from the larger inroad of the savage, then called "war;" and from this feeling arises the constant cry for more troops, and, in the case of plunder, the hope, however unreasonable, for compensation. Considerable difficulty would no doubt be experienced in any country, and almost under any circumstances, however favourable, in establishing such a systematic colonization; because, in the first place, great care, attention, and some time, must be devoted to the selection of the sites and necessary regulations for their filling up with people; and where all are looking, from necessity or from zeal for their newly adopted country, to the speedy development of its resources, such measures, however well calculated to promote the ultimate prosperity of the settlement, might cause some delay in the first instance, and for this reason be perhaps at first regarded unfavourably by the colonists. These and other obstacles might exist; but I apprehend none so insuperable that they may not, under almost any conceivable circumstances, be overcome; and, if the local government were determined to carry such a scheme into operation, the colonists would no doubt soon perceive how well adapted to their circumstances and position such a system would be, and it would receive their hearty cooperation. Titles being granted to lands under the proviso of the owner being liable to be called upon for active service in the defence of his district, if necessary, something in a similar manner as land was held of old under the feudal system, might facilitate its adoption, and, in the position of a people in a new country, ought not, and could not, be considered by them as a hardship.

This, it is conceived, would operate alike beneficially on the colony and on the mother country, by making the inhabitants of the one feel a more general interest, and exert more energy of mind, in the management of their own affairs and activity of body, when necessary, in carrying their plans and arrangements into execution, and at the same time diminish the expenditure now incurred by the mother country in providing for the defence of such colonies, as they could be defended with a smaller amount of regular troops, and, by enabling these troops to be concentrated in central positions in the country, increase the moral effect their presence inspires, keep up with greater facility their own efficiency and discipline, while they would ever be in immediate readiness to act with promptitude upon any point where it might be requisite.

The location of the military pensioners at New Zealand, and the contemplated establishment of military villages on the frontier of the Cape of Good Hope, is indeed a commencement of a similar system, of a plan ultimately tending to place the colonists in the position of being able to take a more active share in the defence of the colony.

A passage in the History of Rome, by the late Dr. Arnold, descriptive of the early rise of the Roman people to greatness and power, appears to me so remarkably adapted as an illustration of this subject, thet I may be pardoned for quoting it here, more especially as this work gives such beautiful accounts of the early wars of the city of Rome, and such graphic and vivid descriptions of the splendid campaigns of Hannibal, and minute account of the topography of the seat of war, as to make it, independently of its vast generally instructive interest, well worthy the careful study of the military reader. "To give a further organization to the commons, he is said to have instituted the festivals called Paganalia and Compitalia. In the tribes in the country, many strongholds on high ground, pagi, had been fixed upon as a general refuge for the inhabitants and their cattle in case of invasion. Here they all met once a year, to keep festival, and every man, woman, and child, paid on these occasions a certain sum, which being collected by the priests, gave the amount of the whole population. And for the same purpose, every one living in the city paid a certain sum at the temple of Venus Libitina for every death, and a third at the temple of Youth for any son who came to the age of military service. The Compitalia in the city answered to the Paganalia in the country, and were a yearly festival in honour of the Lares or guardian spirits, celebrated at all the compita or places where several streets meet."

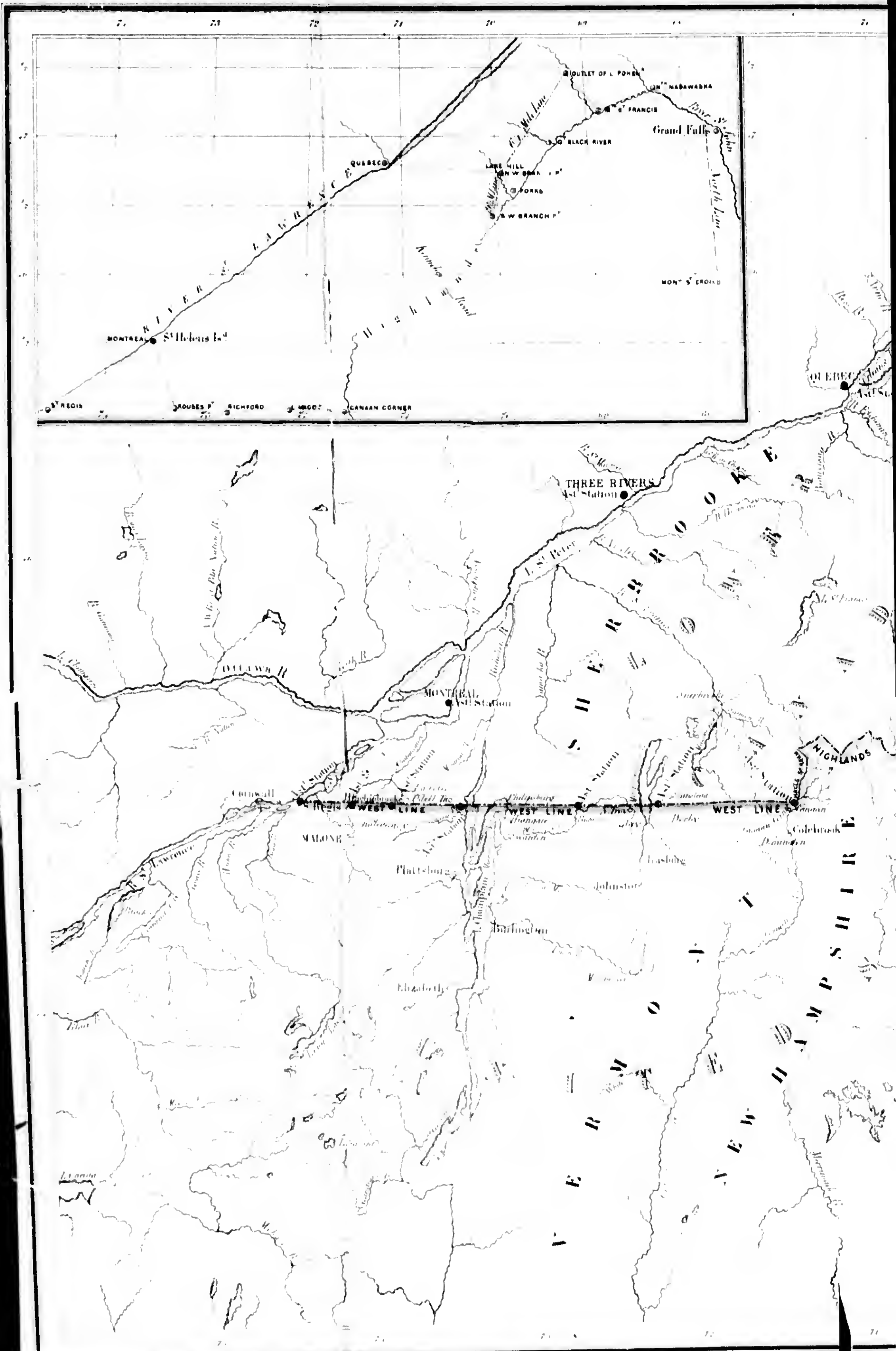
By this arrangement the city of Rome was surrounded by numerous strongholds (fortresses), through which an invading enemy must first pass before approaching the city; and the Roman general, in the event of his country, or that of the allies of the Roman people, becoming the seat of war, knew at once the exact spot at which he would find his allies in each part of the country, mustered in their strongholds, and ready to cooperate with his army, either for purposes of defence or offence. The advantages of such a system need not be dwelt upon: it was the commencement of the greatness of the city of Rome. Substituting, then, for the city of Rome, the head quarters of the colony, and for the tribes, our districts, whether native or European, this system may be made applicable to us; and in the native districts a meeting might, in a similar way, be held with great advantage each year, at which an officer of the government, as representative of Her Majesty, might explain to them the advantages they enjoy, the duties required of them as British subjects, and generally excite them forward to seek the benefits of true religion and civilization thus offered to them.

Having had my attention drawn to this subject while employed at Natal, and believing that the general adoption of a plan of colonization, the general outline of a part of which has been attempted to be sketched in this paper, would, while relieving in some degree the burden of the military protection of such colonies from Great Britain, at the same time tend to make the colonists themselves more active, enterprising, and useful subjects of Her Majesty, these remarks are with deference offered to my brother officers, in the hope that it may induce others to the consideration of the subject, and thus, perhaps, in some degree aid in the furtherance of a well devised system of colonization, so desirable an object to be attained, alike to our country and her colonies.

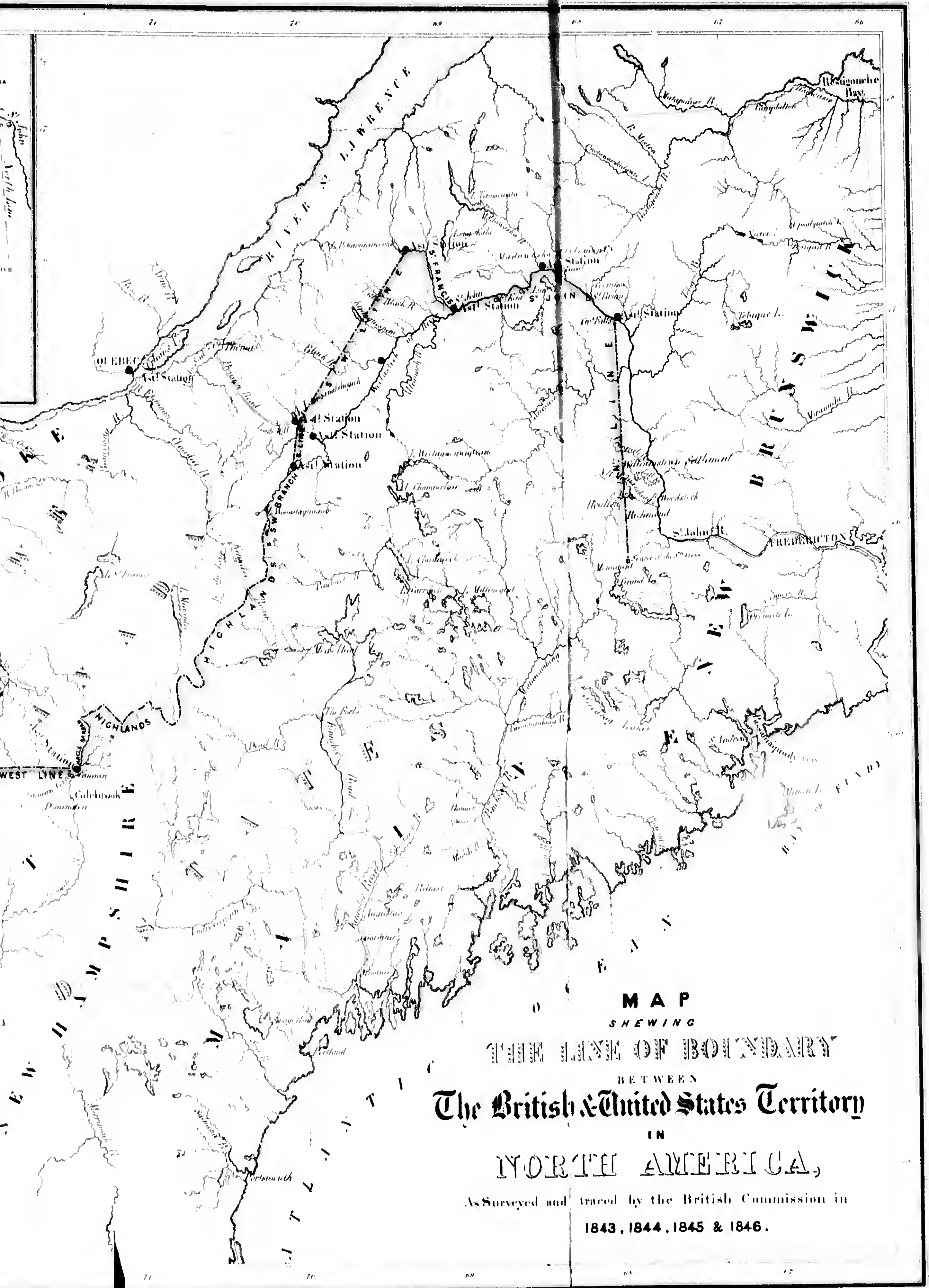
C. J. G.

Southampton, June 12, 1848.

PLAN OF THE CLIFF AFTER THE EXPLOSIONS



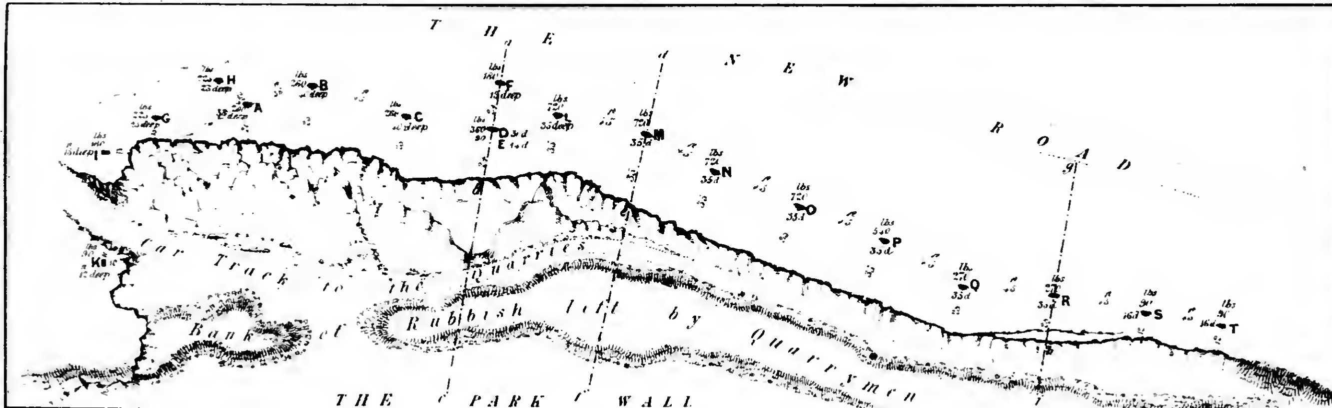
John Weale … High Holborn


MAP
SHEWING
THE LINE OF BOUNDARY
BETWEEN
The British & United States Territory
IN
NORTH AMERICA,
As Surveyed and traced by the British Commission in
1843, 1844, 1845 & 1846.
RIVER ST. LAWRENCE
QUEBEC
NEW BRUNSWICK
FREDERICTON
St. John R.
Restigouche Bay
HIGHLANDS
WEST LINE
Colebrook
NEW HAMPSHIRE
Portsmouth
ATLANTIC OCEAN

Memoranda on Mines in the Phoenix Park Dublin Pl. I.

T H a E

d

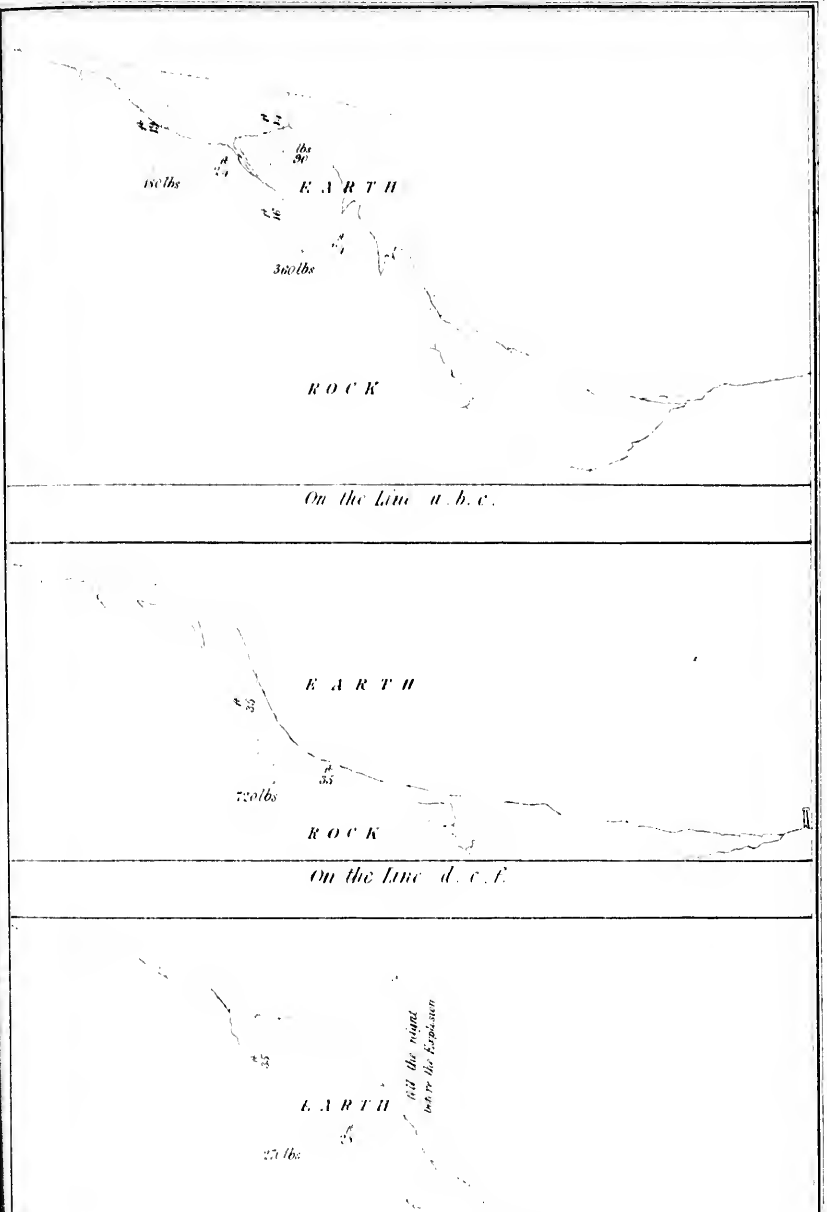


PLAN OF THE CLIFF BEFORE THE EXPLOSIONS

C.F. Cheffins, Lithog.r Southampton Buildings Holborn.

PLAN OF THE CLIFF AFTER THE EXPLOSIONS.

Memora

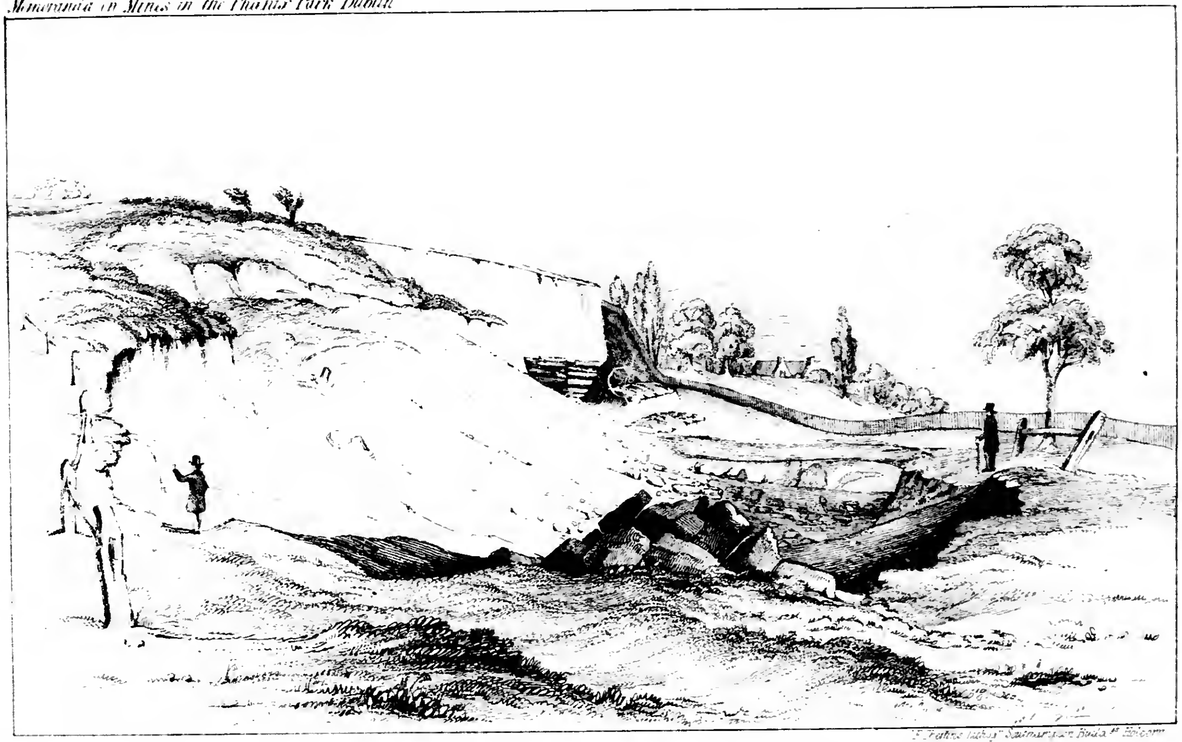


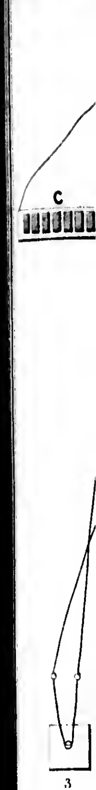
SECTIONS BEFORE AND AFTER THE EXPLOSIONS

Pl 3

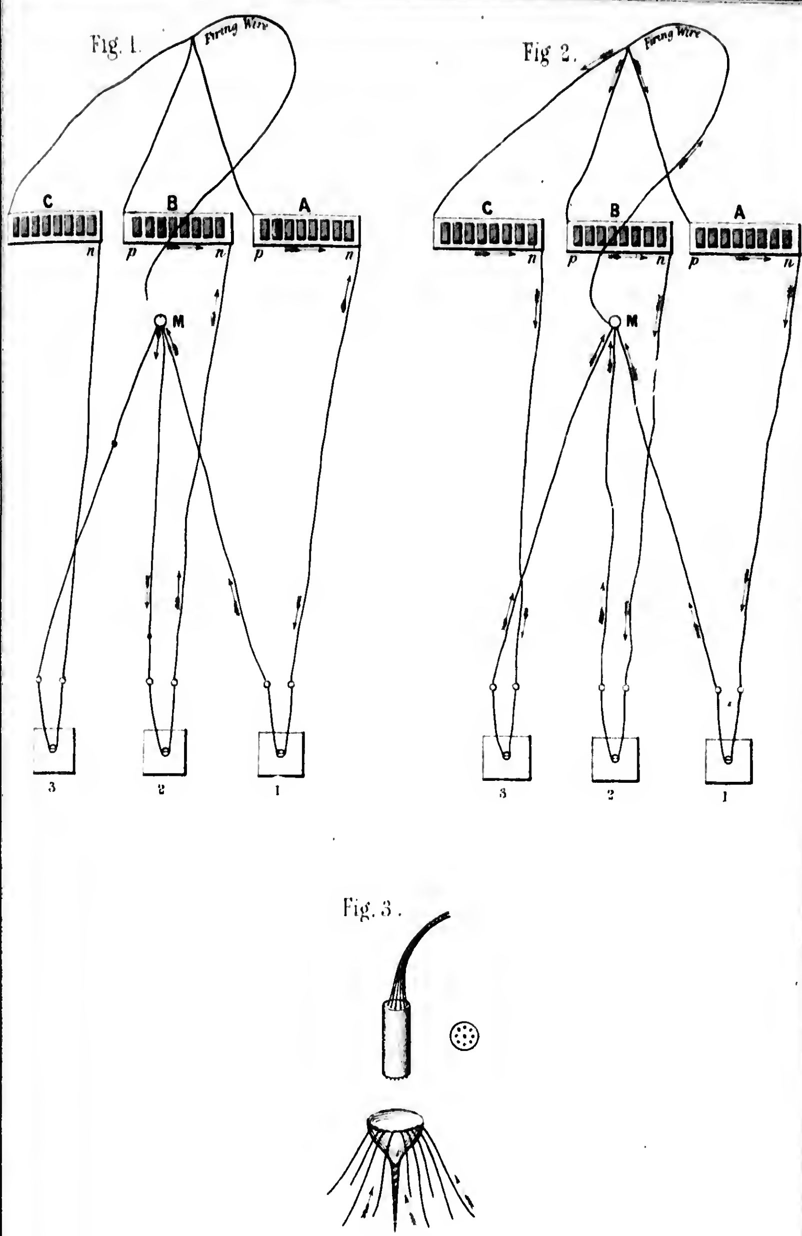
[illegible]

Memoranda on Mines in the Phœnix Park Dublin Pl. 3



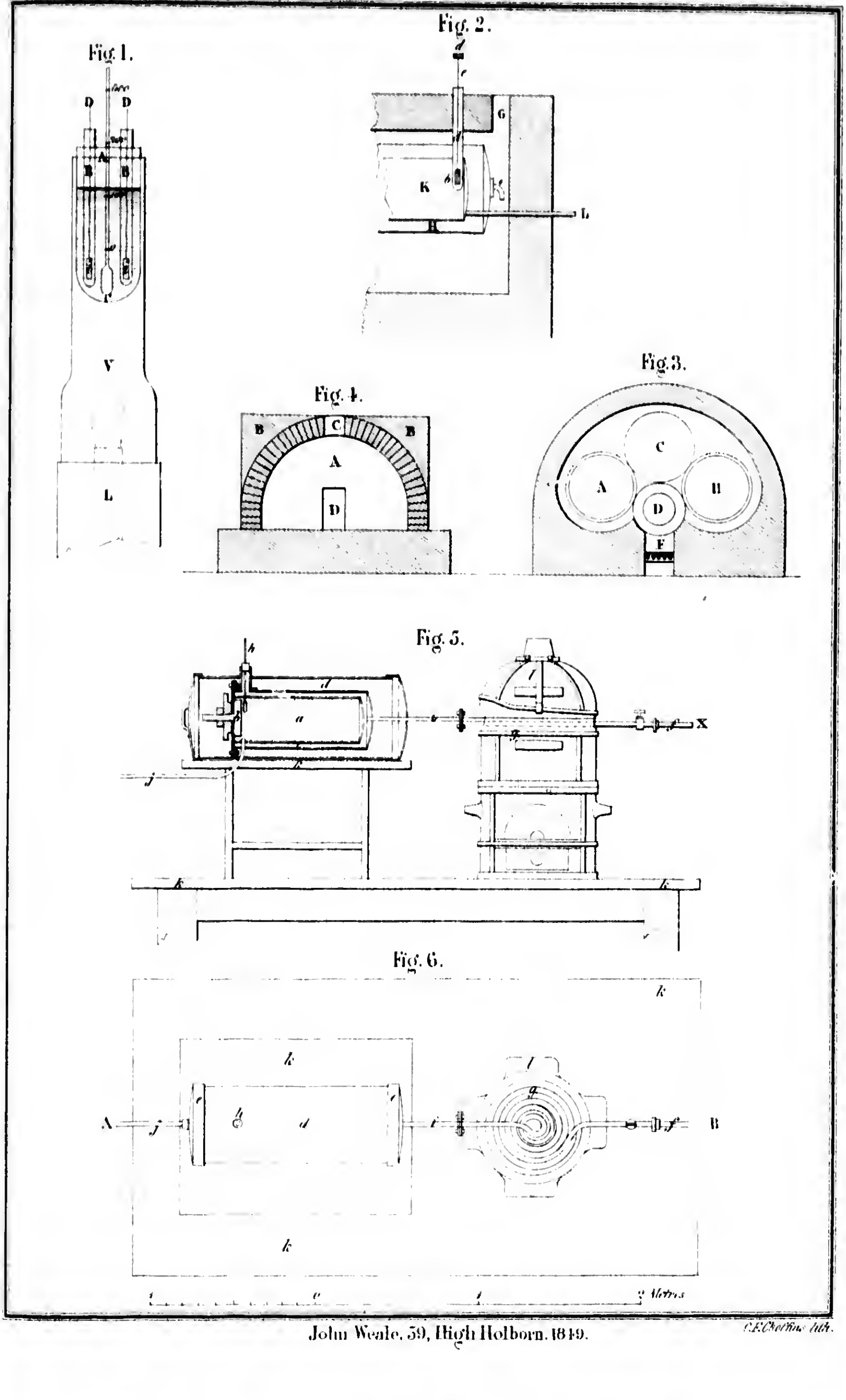


Sartory



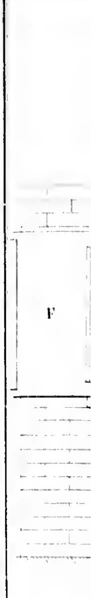
…1. Battery neutralized … Fig. 2. Battery with Circuit complete … Fig 3 Mechanical mode of Firing.

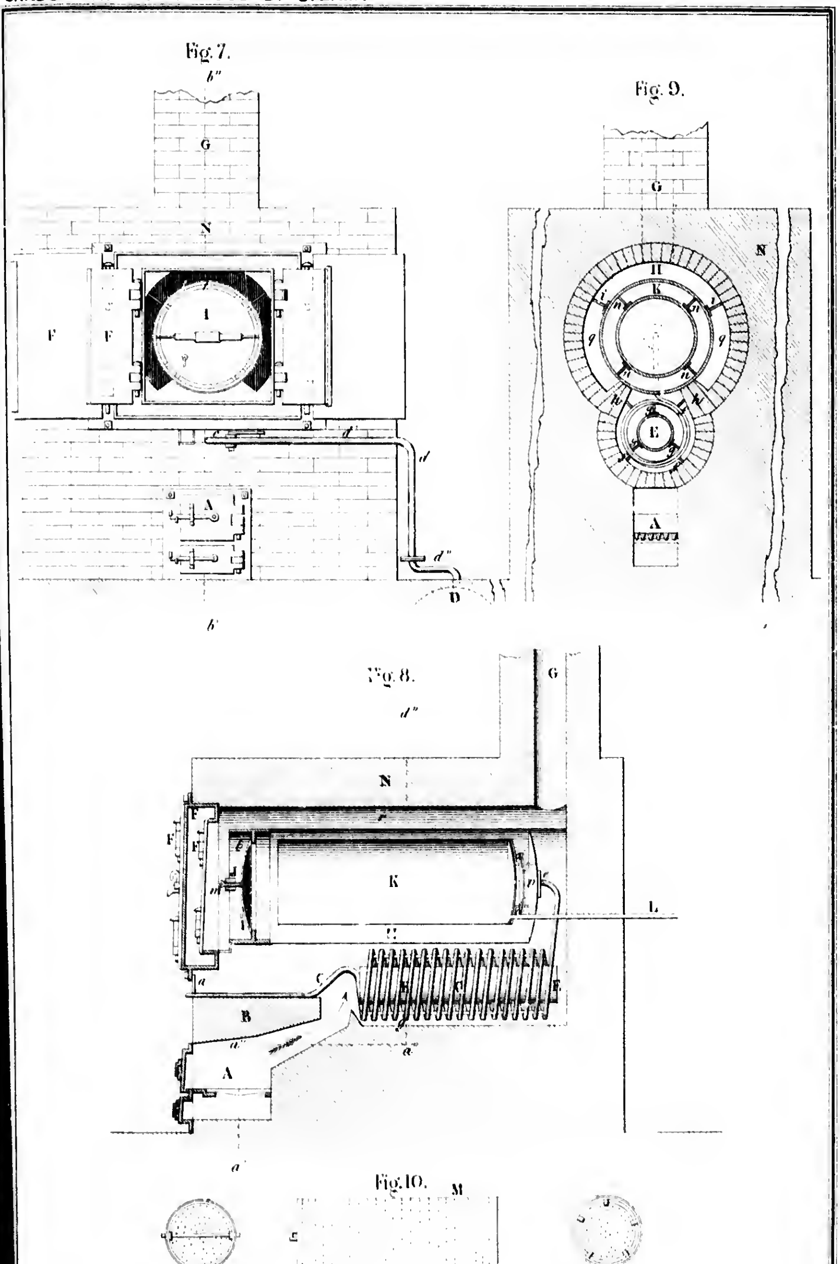
CARBON



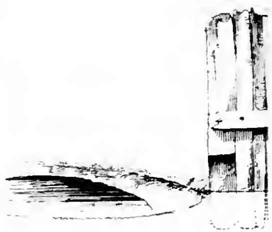
John Weale, 59, High Holborn. 1849.
C.F. Cheffins lith.

CARBONIZ



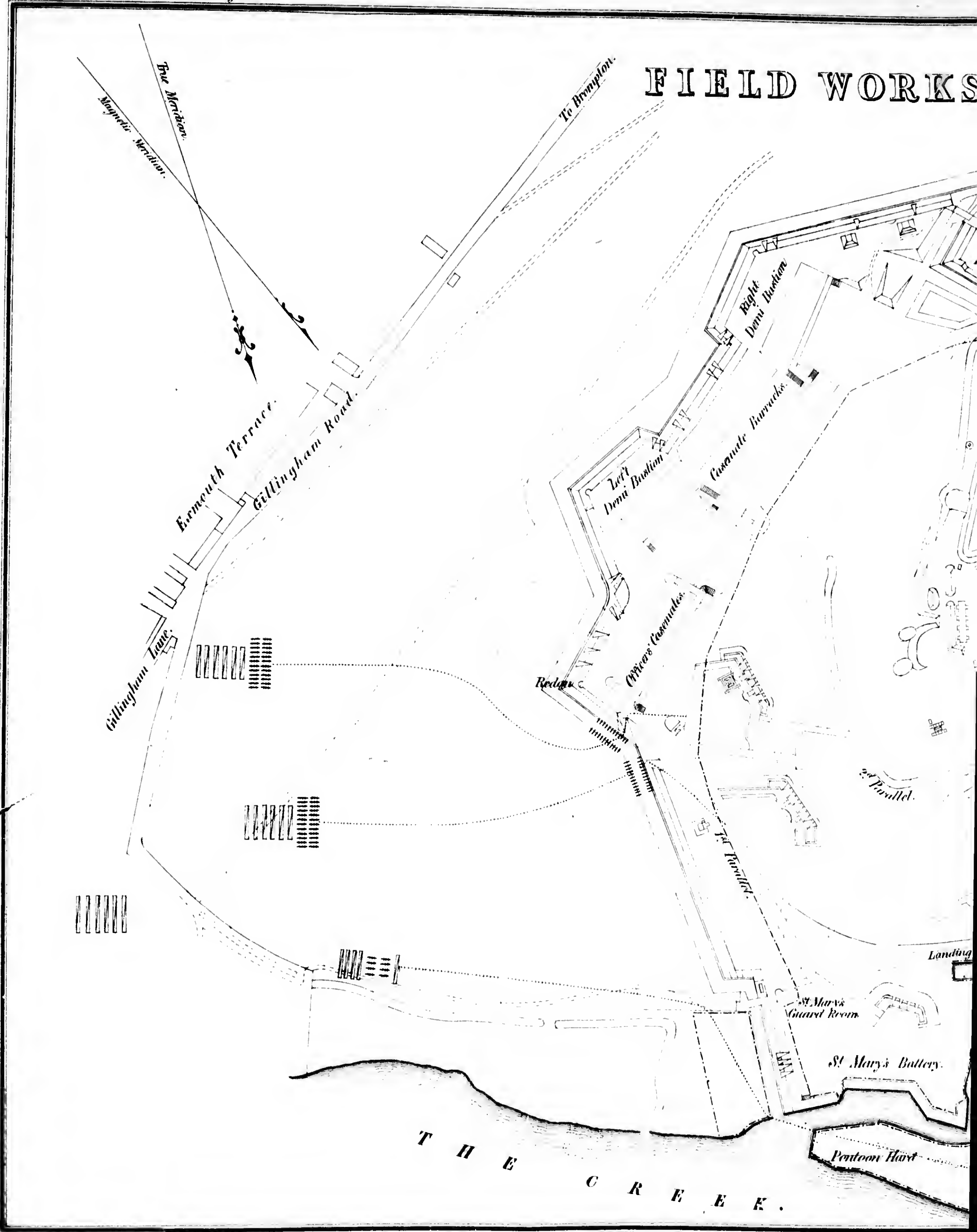


John Weale, 59, High Holborn, 1849. C.F. Cheffins lith.

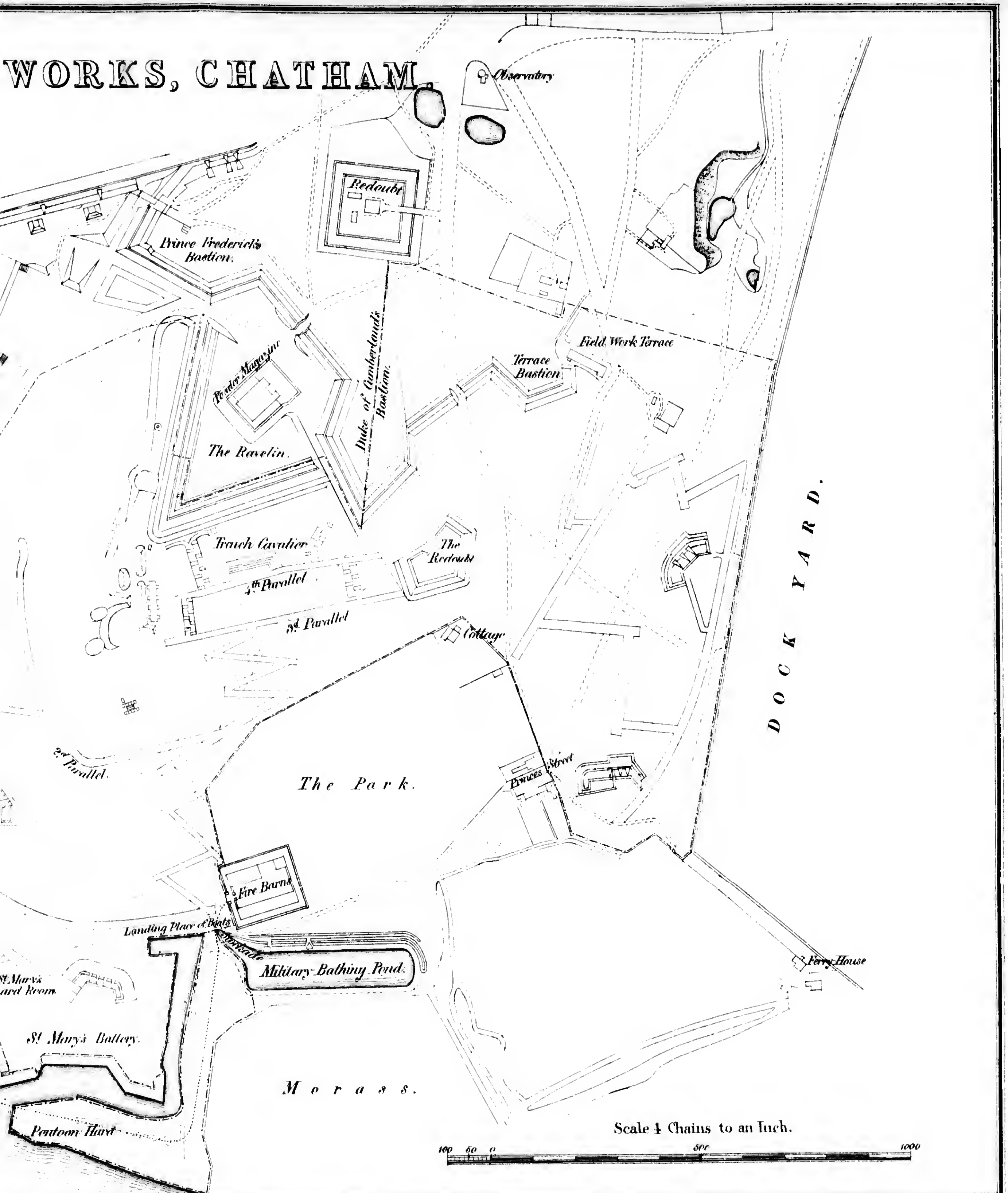


Plan shewing the position of the Charges.

John Weale, 59, High Holborn. 18[illegible]

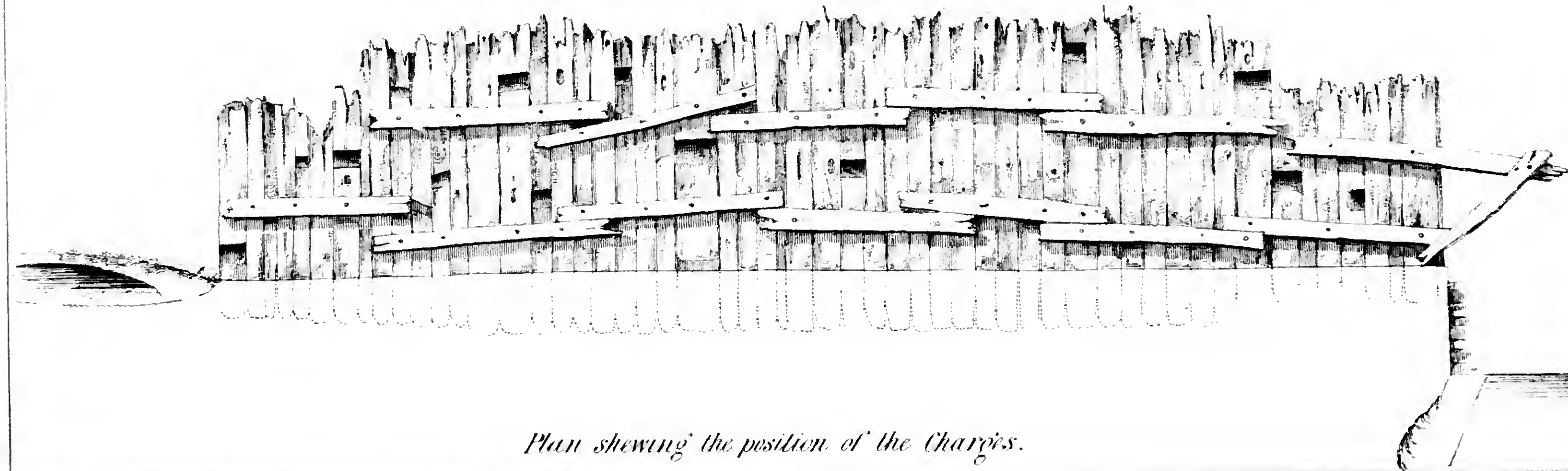


John Weale, 59, High Ho



John Weale, 59, High Holborn. 1849.
C.F.Cheffins, Lithog. Southampton Buildings, Holborn.

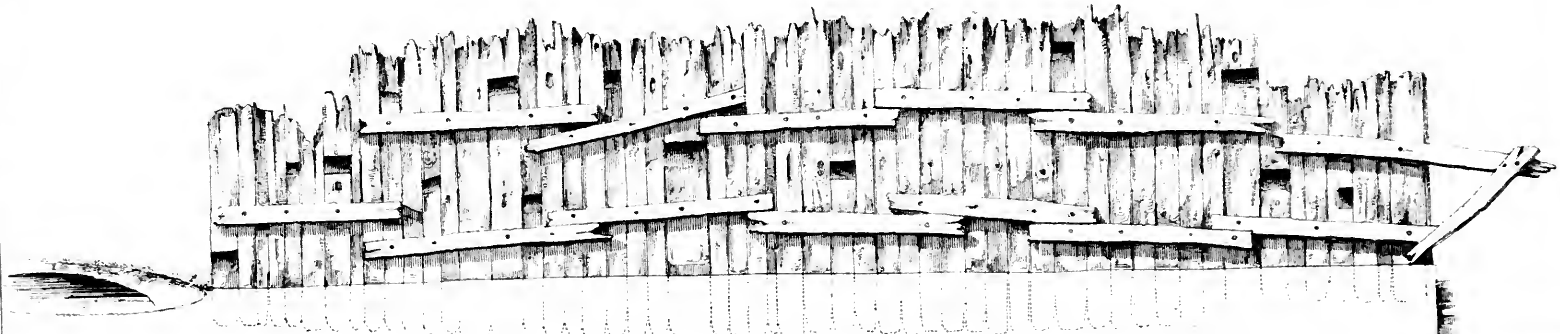
Rear Elevation of the Stockade breached on the 11th August 1848.
shewing its appearance before the Explosion.



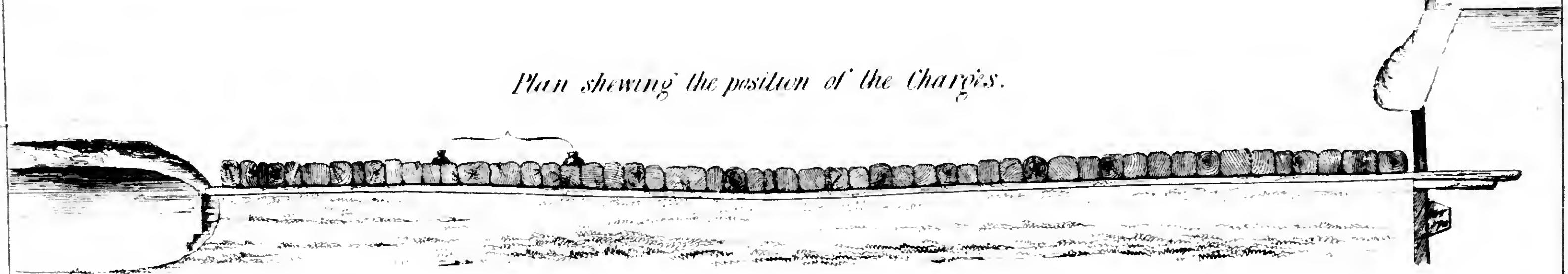
Plan shewing the position of the Charges.

John Weale, 59, High Holborn. 1849.

Rear Elevation of the Stockade breached on the 11th August 1848.
shewing its appearance before the Explosion.



Plan shewing the position of the Charges.



Each Charge consisted of 100 lbs of Powder placed in equal quantities in two Sand Bags.
Three Bags containing 100 lbs. weight of common Earth were placed, one on the top of the Charge and another at each end. The Charges were fired simultaneously by Lieut. A. J. Clarke R.E.

[illegible]
and another at each end. The Charges were fired simultaneously by Lieut. A. J. Clarke R.E.

Front Elevation of the Stockade breached on the 11th August 1848,
shewing its appearance after the explosion.

Scale of Feet.

0 5 0 10 20 Feet

C. F. Cheffins, Litho. Southampton Bdgs. Holborn.

John Weale, 59, High Holborn. 1849.

Operations at Chatham, 11th Aug. 18[illegible]

PLAN Nº 3.

DRAWINGS

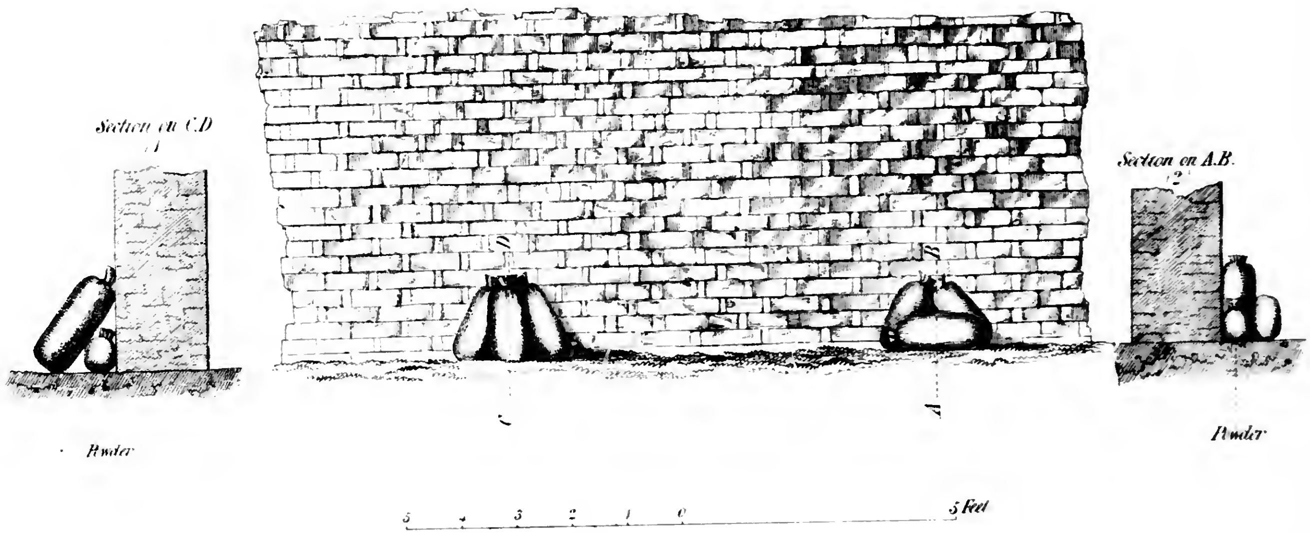
DRAWINGS

Showing the effect produced on the Enclosure Wall of the Fire Barns by the explosions of two charges of Gun Powder fired against it on the 11th Augt 1848.

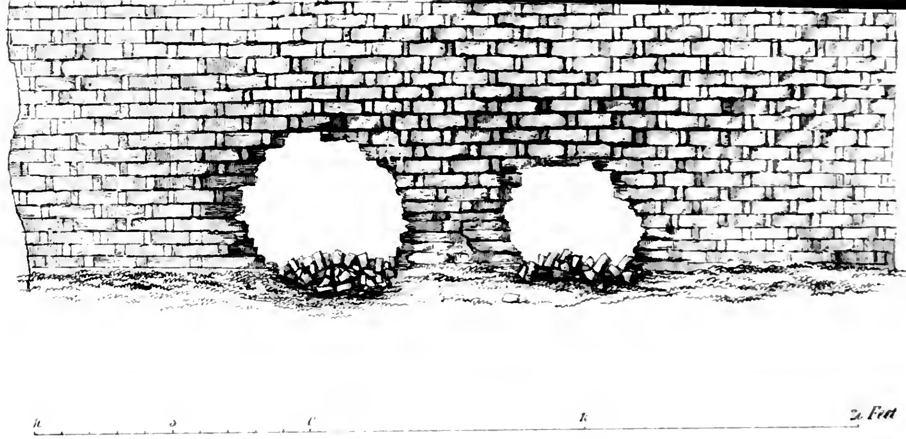
DRAWINGS

Shewing the effect produced on the Enclosure Wall of the Fire Barns by the explosions of two charges of Gun Powder fired against it on the 11th Augt 1848.

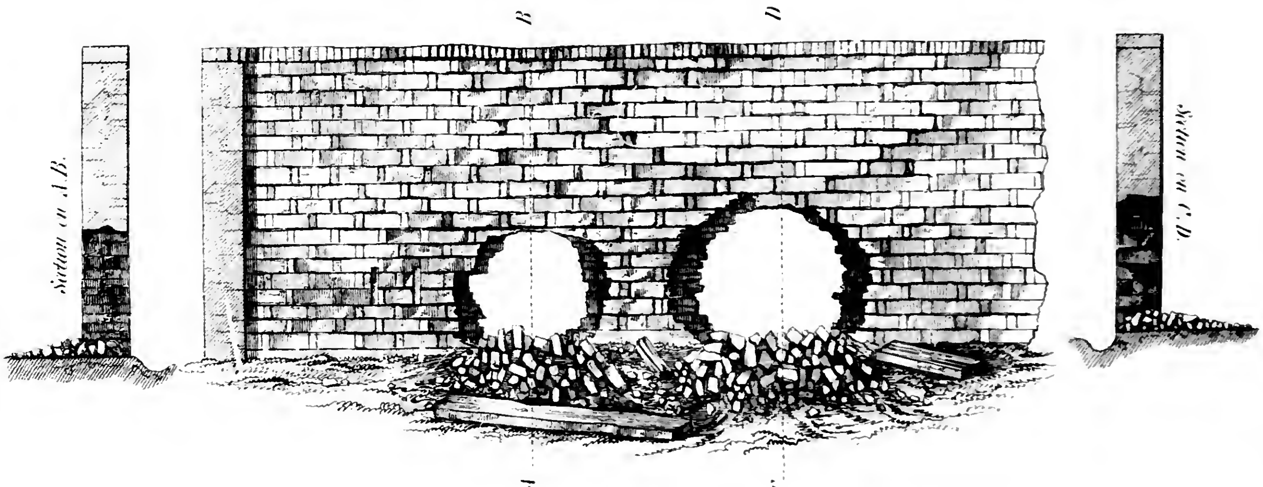
Exterior Elevation shewing the Position of the charges and the disposition of the sand bags.



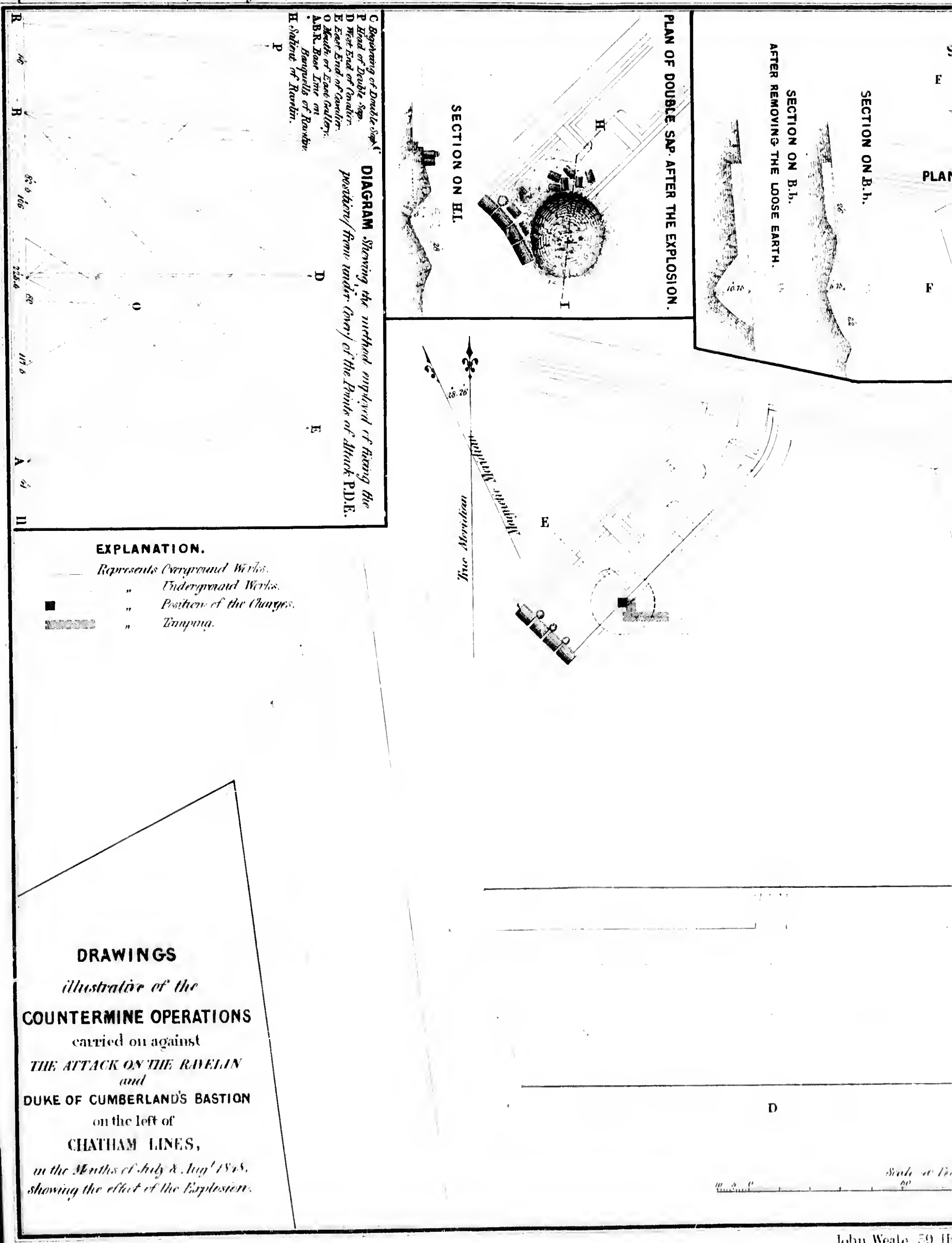
Exterior Elevation after the Explosion

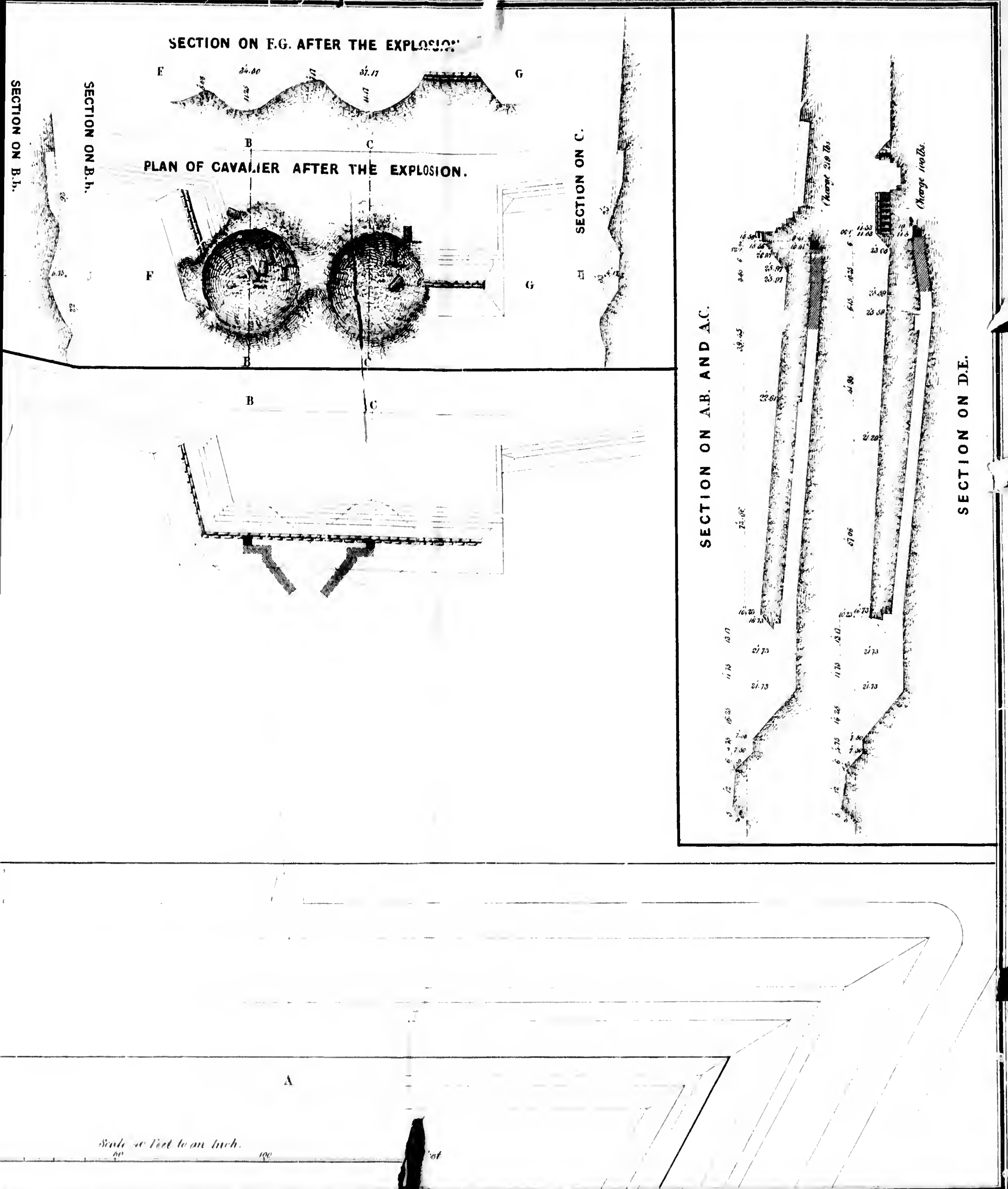


Interior ... after the Explosion.



John Weale, 59, High Holborn 1849.


PLAN OF DOUBLE SAP AFTER THE EXPLOSION.
SECTION ON H.I.
SECTION ON B.b.
SECTION ON B.b.
AFTER REMOVING THE LOOSE EARTH.
DIAGRAM Showing the method employed of fixing the position from under Cover of the Points of Attack P.D.E.
C Beginning of Double Sap.
P Head of Double Sap.
D West End of Cavalier.
E East End of Cavalier.
O Mouth of East Gallery.
A.B.R. Base Line on Banquette of Ravelin.
H Salient of Ravelin.
True Meridian
Magnetic Meridian
18.26'
EXPLANATION.
Represents Overground Works.
" Underground Works.
" Position of the Charges.
" Tamping.
DRAWINGS
illustrative of the
COUNTERMINE OPERATIONS
carried on against
THE ATTACK ON THE RAVELIN
and
DUKE OF CUMBERLAND'S BASTION
on the left of
CHATHAM LINES,
in the Months of July & Aug.t 1848,
showing the effect of the Explosion.
John Weale, 59, H



John Weale, 59, High Holborn. 1849.
C.F. Cheffins Lithog. Southampton Buildings, Holborn.

Plan No. 5.

...un. 11th Aug. 1813.

Chatham. 1848.

PLANS AND SECTION

To show the Position of the Charges by which the Head of a Serpentine Sap was destroyed in the Siege Operations of the 11th of Aug!

PLANS SHEWING WORK PERFORMED BEFORE AND AFTER AUG! 7TH 1848.

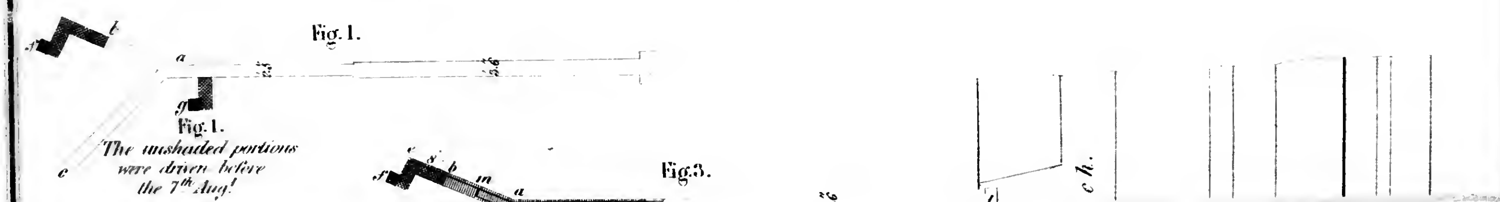


Fig. 1.
The unshaded portions were driven before the 7th Aug!

Chatham. 1848.

PLANS AND SECTION

To shew the Position of the Charges by which the Head of a Serpentine Sap was destroyed in the Siege Operations of the 11th of Aug.t

PLANS SHEWING WORK PERFORMED BEFORE AND AFTER AUG.T 7.TH 1848.

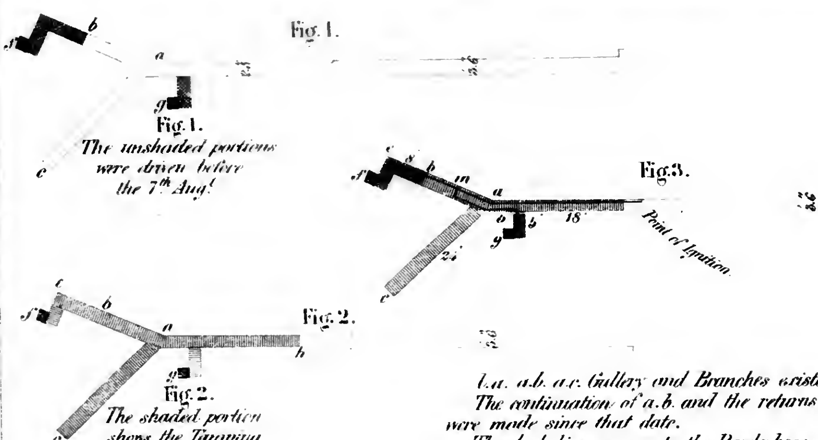
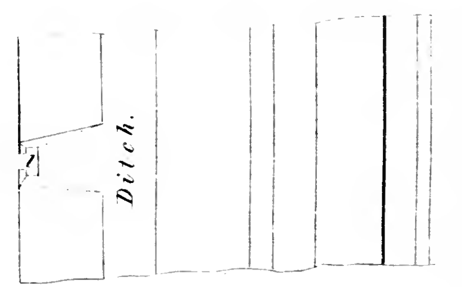


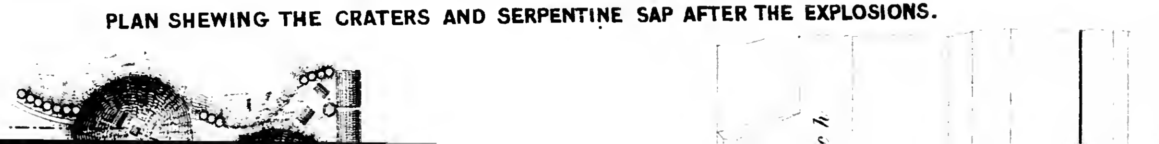
Fig. 1. *The unshaded portions were driven before the 7th Aug.t*

Fig. 2. *The shaded portion shews the Tamping.*



l.a. a.b. a.c. Gallery and Branches existing on the 7th of August.
The continuation of a.b. and the returns to the Charges at f. and c. were made since that date.
The dark line represents the Powderhose, and shews the manner in which it was placed to produce simultaneous Explosions.

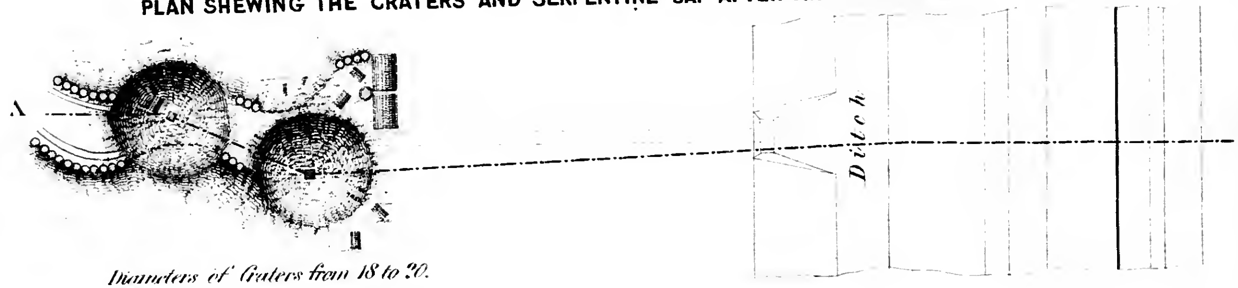
PLAN SHEWING THE CRATERS AND SERPENTINE SAP AFTER THE EXPLOSIONS.



shews the Tamping.

The dark line represents the Powderhose, and shews the manner in which it was placed to produce simultaneous Explosions.

PLAN SHEWING THE CRATERS AND SERPENTINE SAP AFTER THE EXPLOSIONS.



Diameters of Craters from 18 to 20.

Charges of Mines 100 lbs. each.

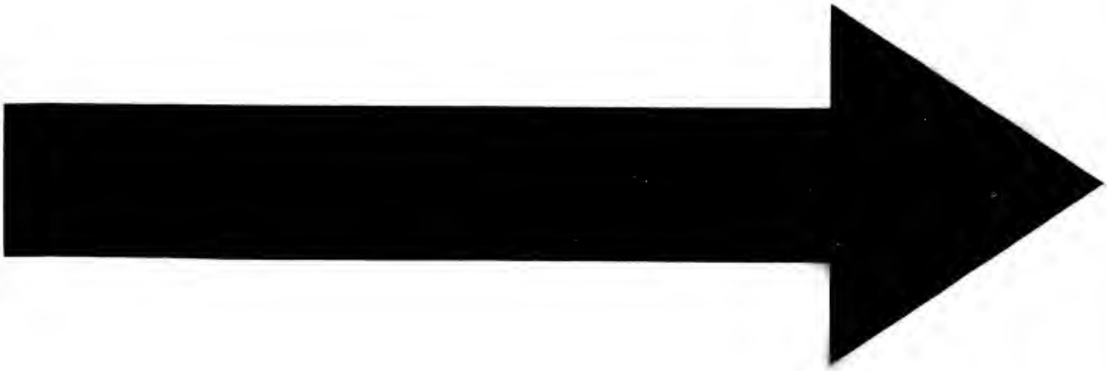
SECTION THROUGH THE CRATERS ON A.B.

Scale 30 Feet to an Inch.

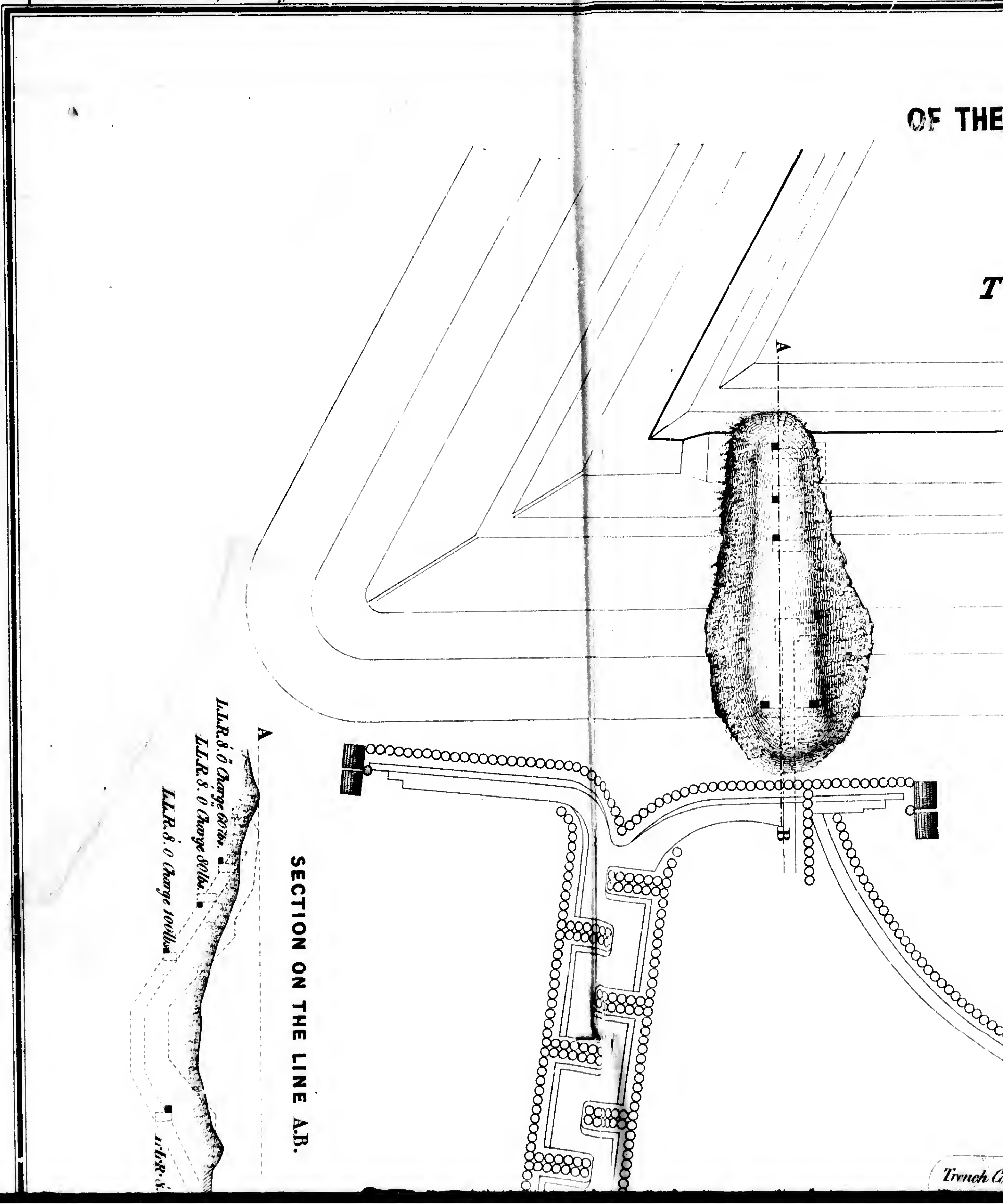
John Weale, 59, High Holborn. 1849.

C.F. Cheffins, Lithog. Southampton Buildings.

after the Engagement.

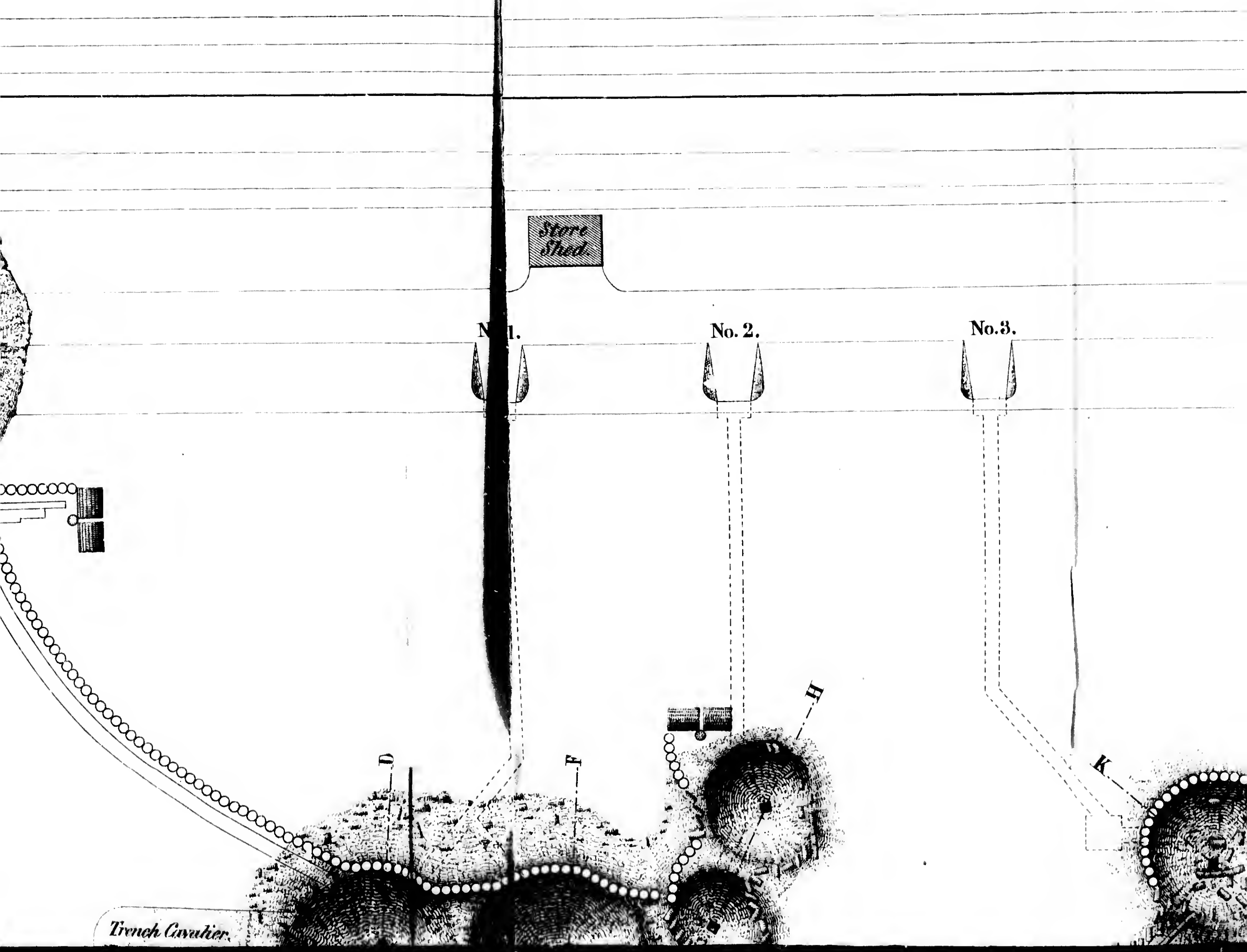


Operations at Chatham, 11th Augt 1848.



PLAN
OF THE SIEGE OPERATIONS IN FRONT OF THE 4TH PARALLEL
OF THE LEFT ATTACK.

THE RAVELIN.

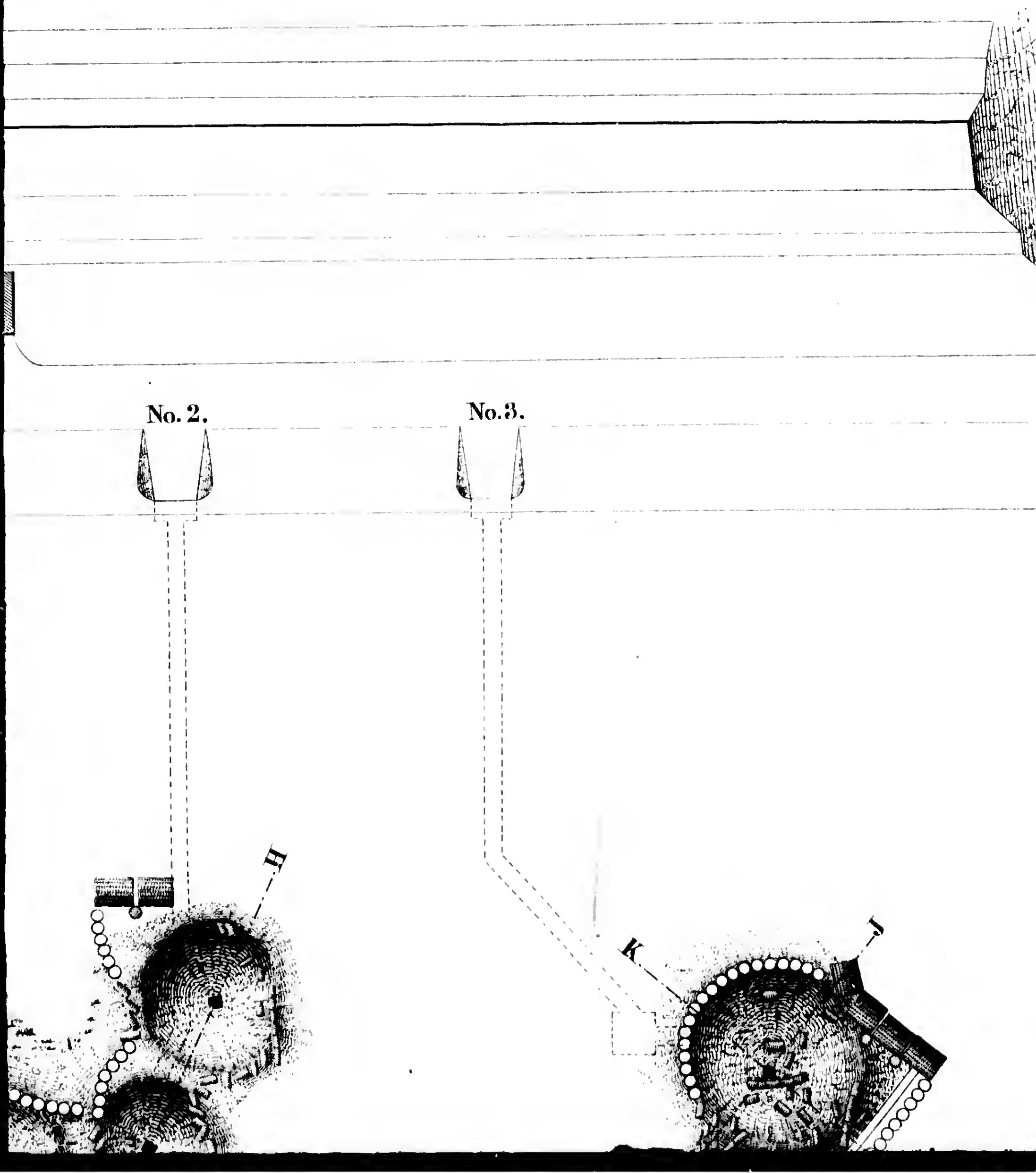


N

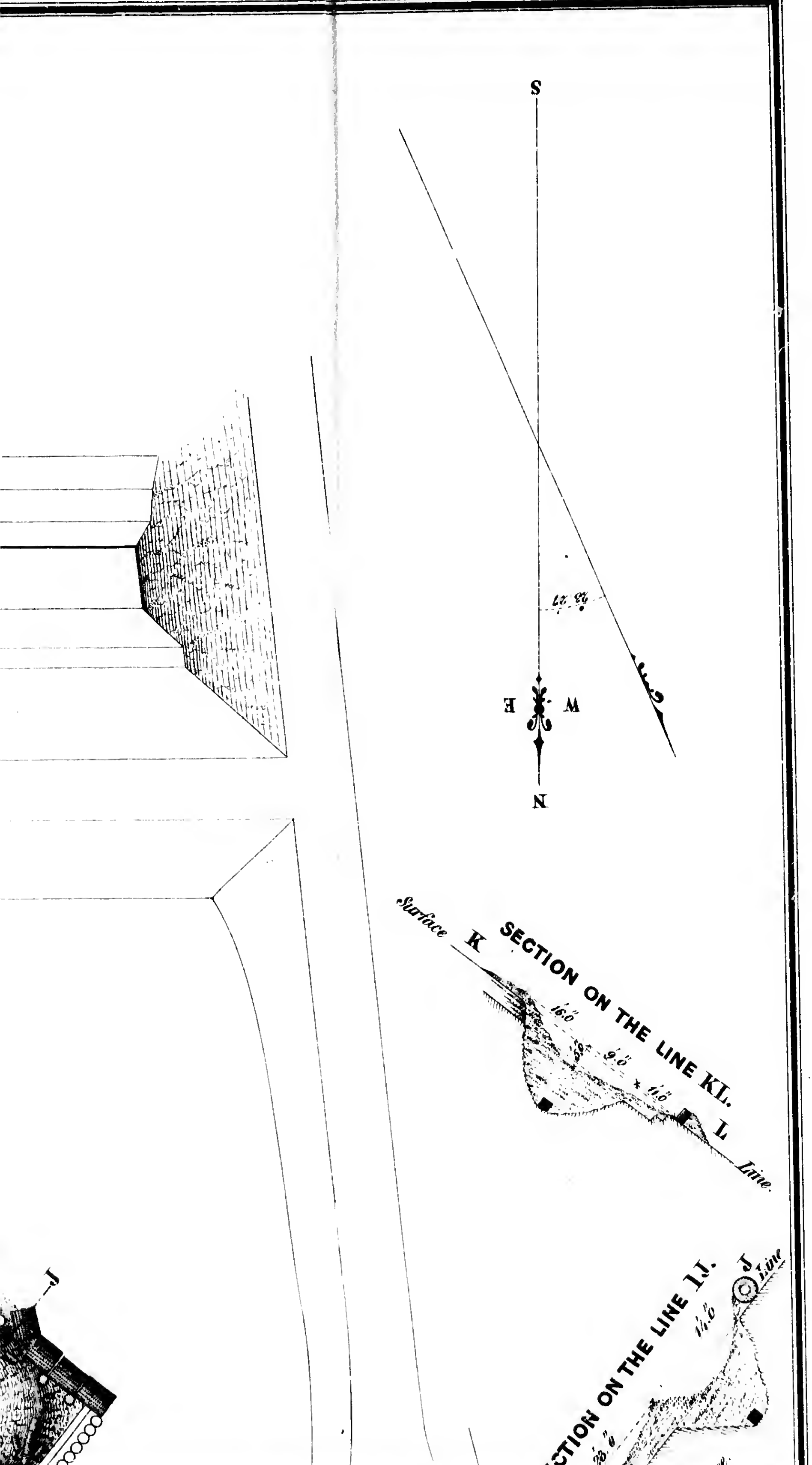
ONT OF THE 4TH PARALLEL

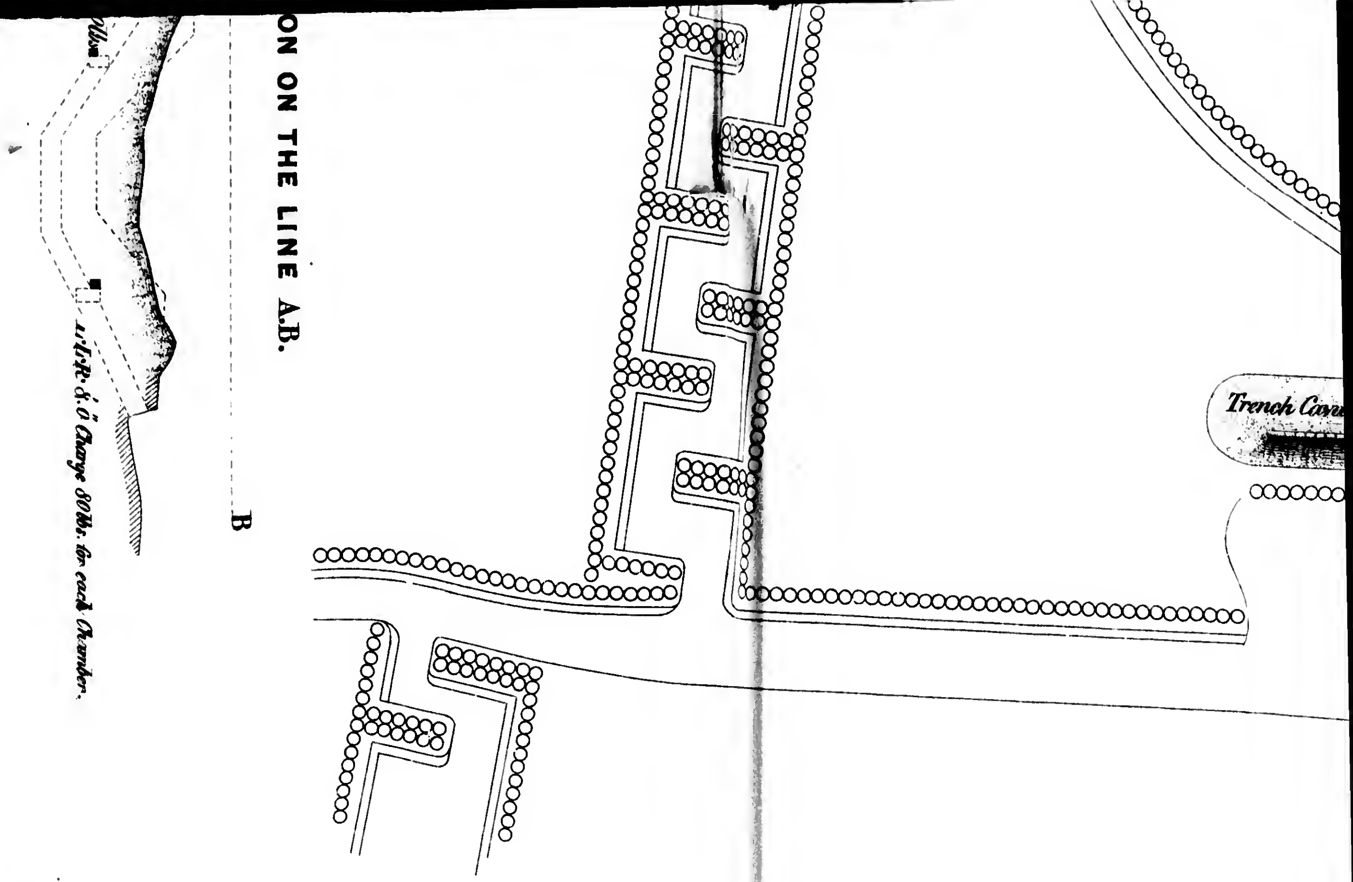
ATTACK.

E L I N.



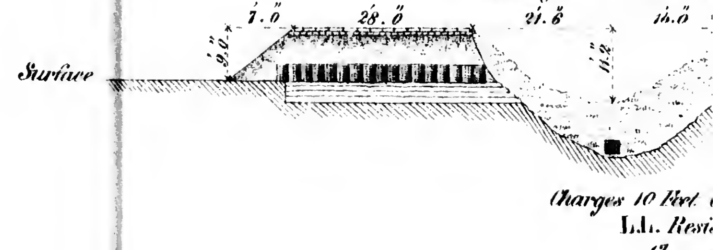
Plan No 6.


S
N
W
E
Surface
K
SECTION ON THE LINE KL.
16.0
9.0
11.0
L
Line
J
SECTION ON THE LINE IJ.
14.0
23.0
Line



ELEVATION OF A PART OF

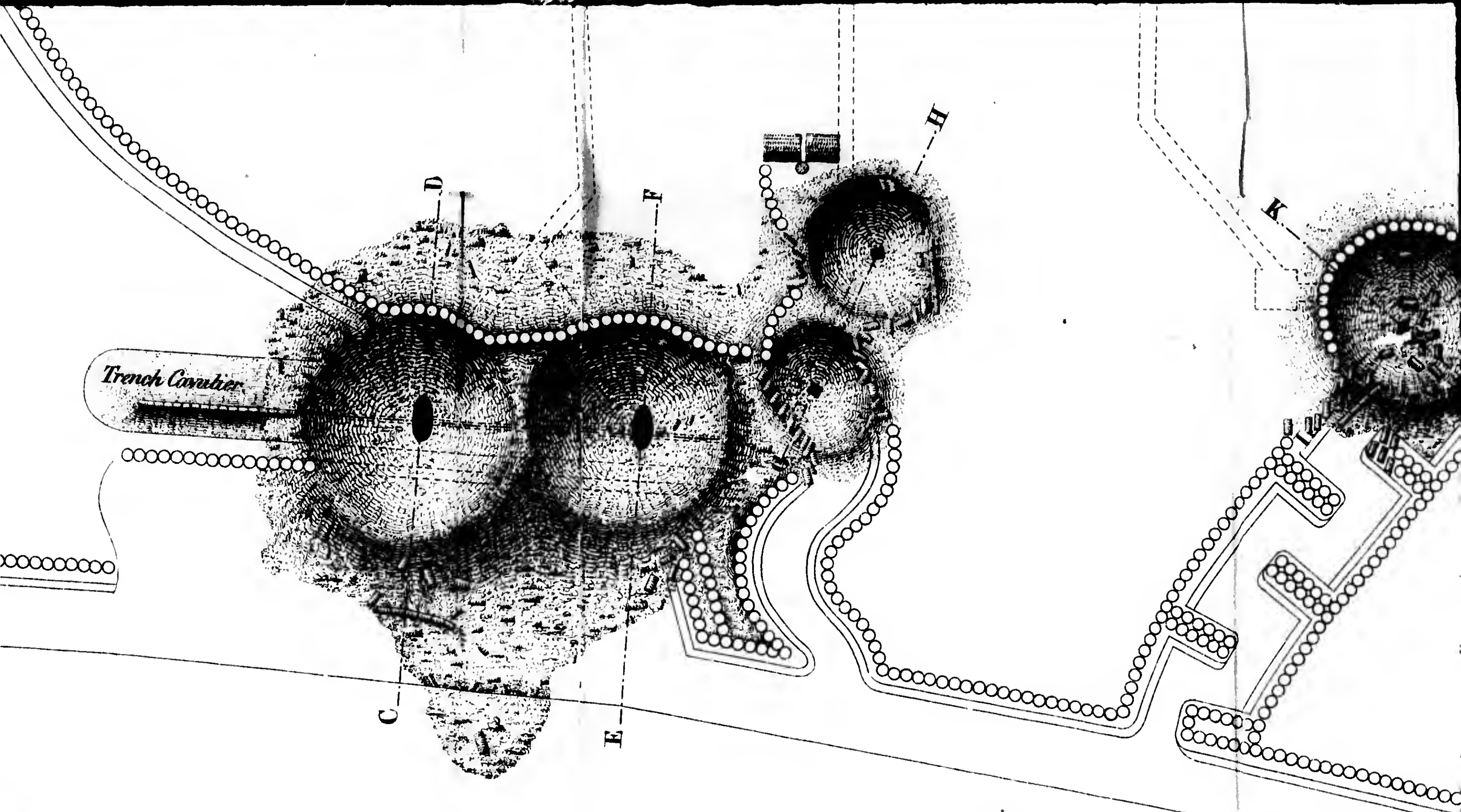
Also shewing in Section th



NOTE.

The Lower Curved Lines in all the Sections shew the form of the Crater when cleared out.

Scale 30 Feet to 1 Inch.



N OF A PART OF THE TRENCH CAVALIER,

hewing in Section the effect of the Mines.

Charges 10 Feet below the Surface Line.
L.L. Resistance 12 Feet.
Charges 21.9 lbs. each.

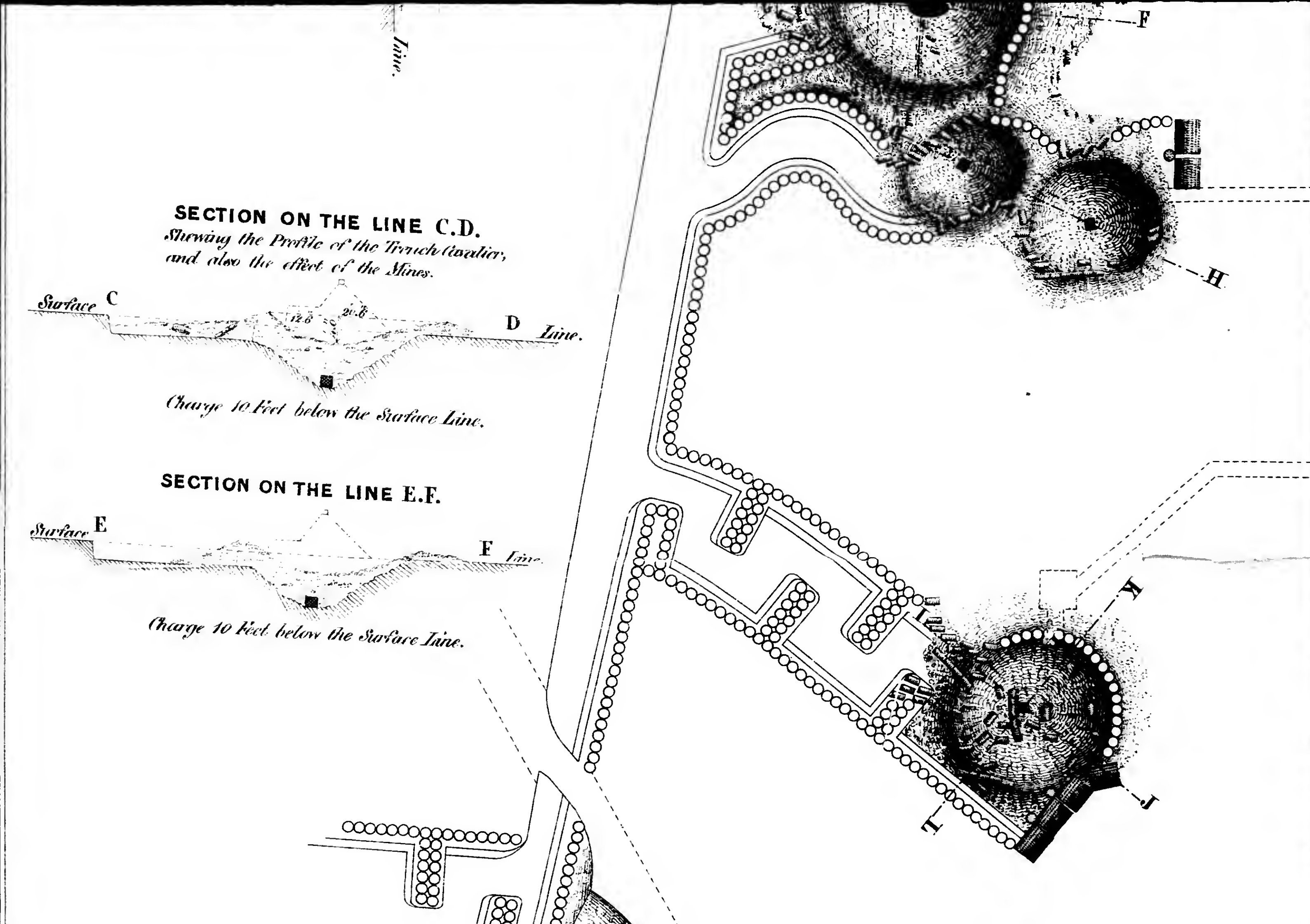
SECTION ON THE LINE C.D.
Shewing the Profile of the Trench Cavalier, and also the effect of the Mines.

Charge 10 Feet below the Surface Line.

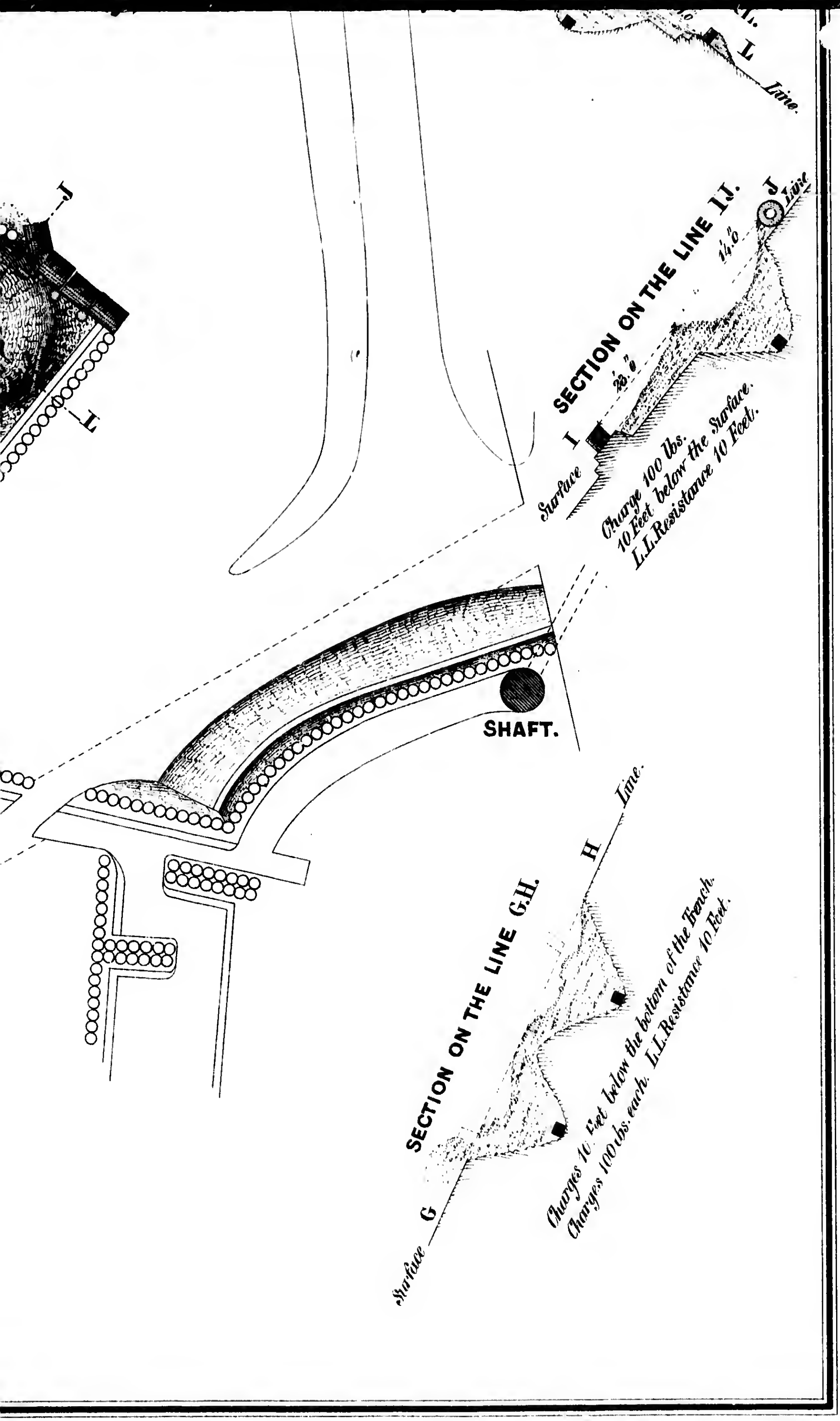
SECTION ON THE LINE E.F.

Charge 10 Feet below the Surface Line.

John Weale, 59, High Holborn. 1849.



Holborn. 1849.



C.F. Cheffins, Lithog. Southampton Buildings, Holborn

l Bastion,

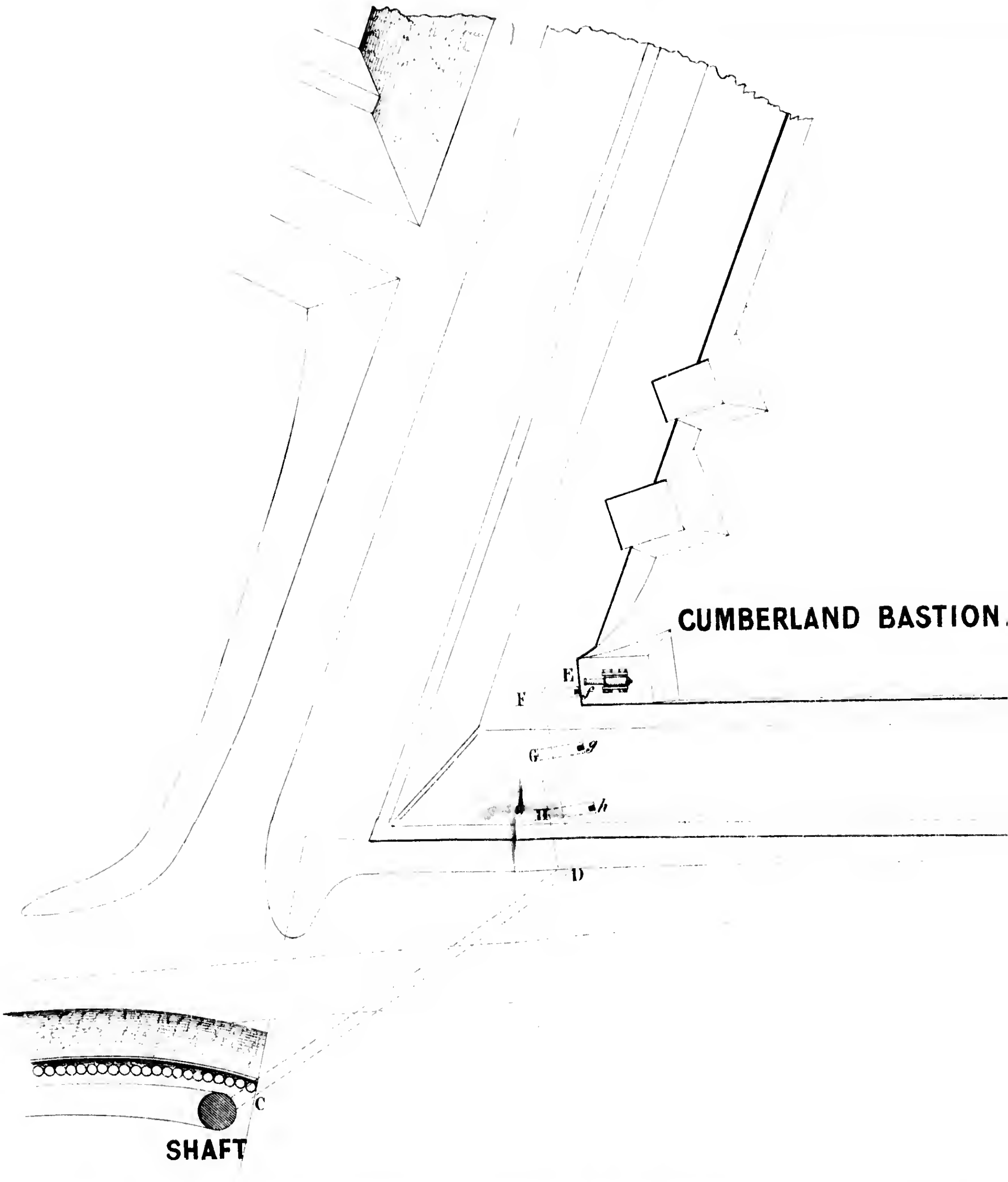
gust 1848.

The followin
Operati

DRAWING

Of the Mining Operations directed agai

ir the purpose of breaching the Salient,

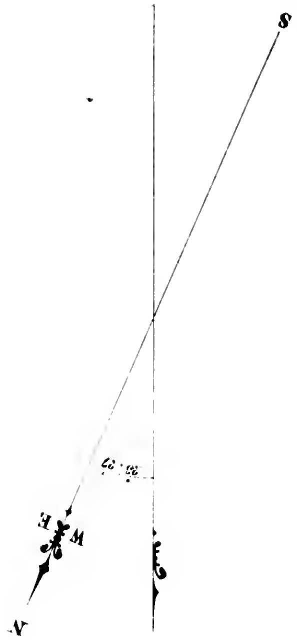


Operations at Ch

RAWINGS

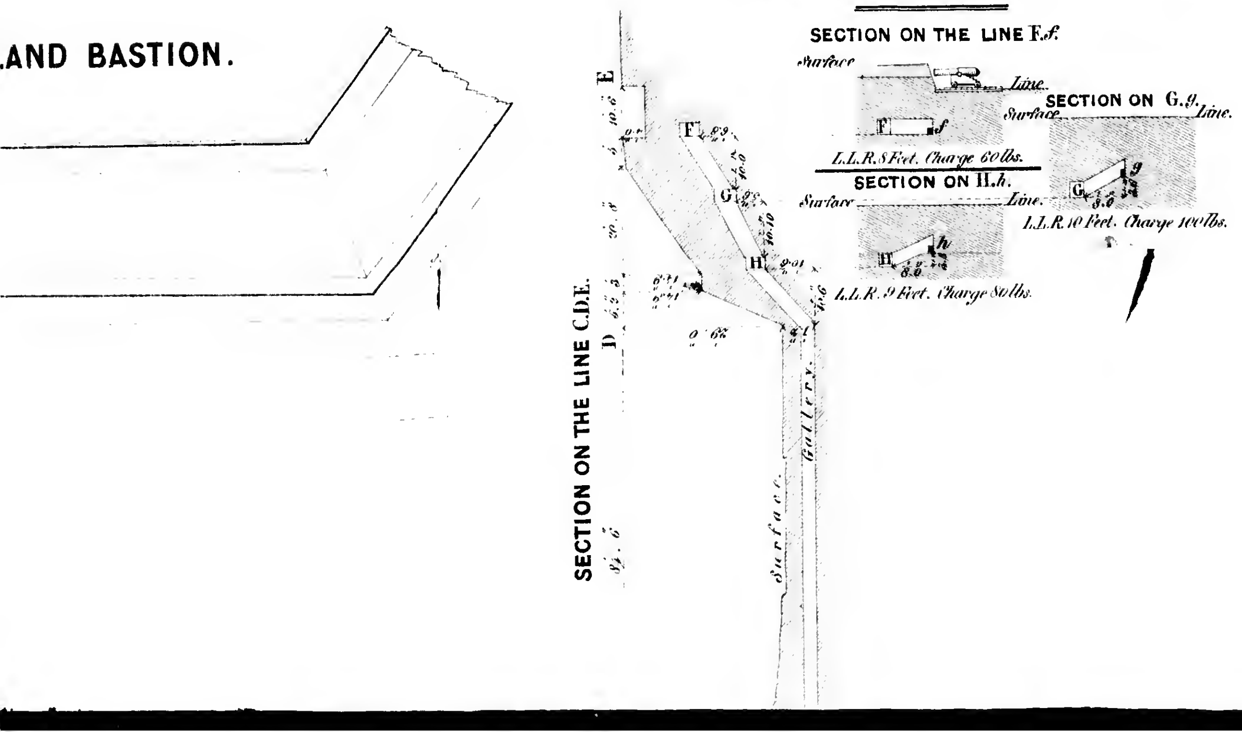
s directed against Cumberland Bastion,

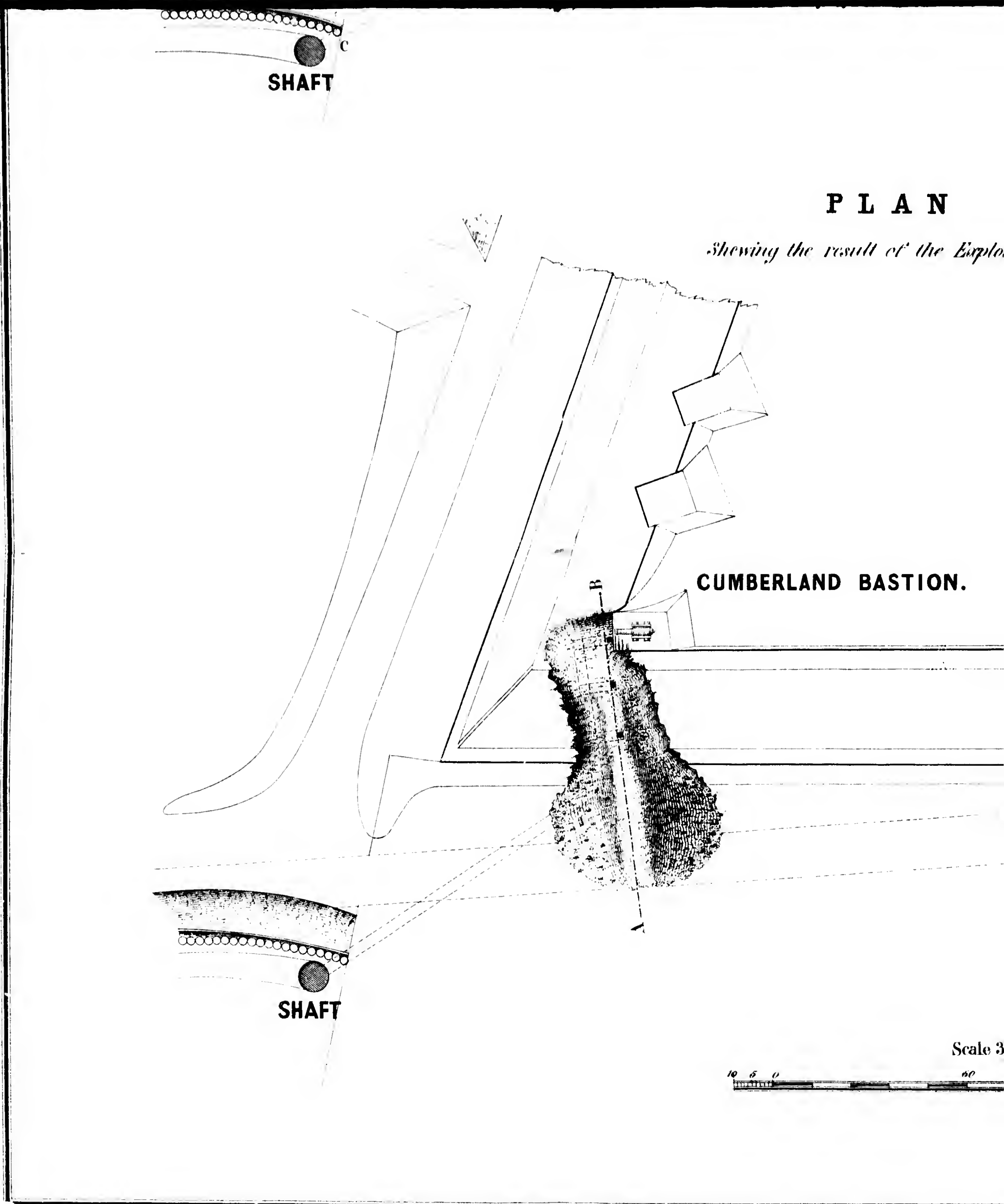
hing the Salient, on the 11.th August 1848.



NOTE.

The following Sections on the Gallery, Branches, Chambers, &c, of the Mining Operations in the Attack of Cumberland Bastion, show the Profile of the Works as they existed before the Explosions.

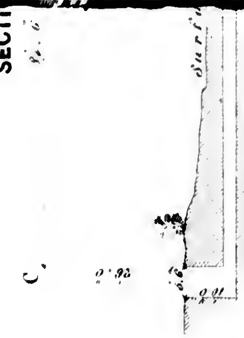




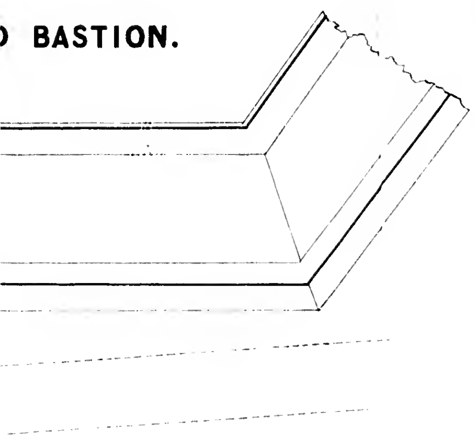
John Weale, 59, High Holborn, 184

PLAN

...sult of the Explosions.



BASTION.



Scale 30 Feet to 1 Inch.

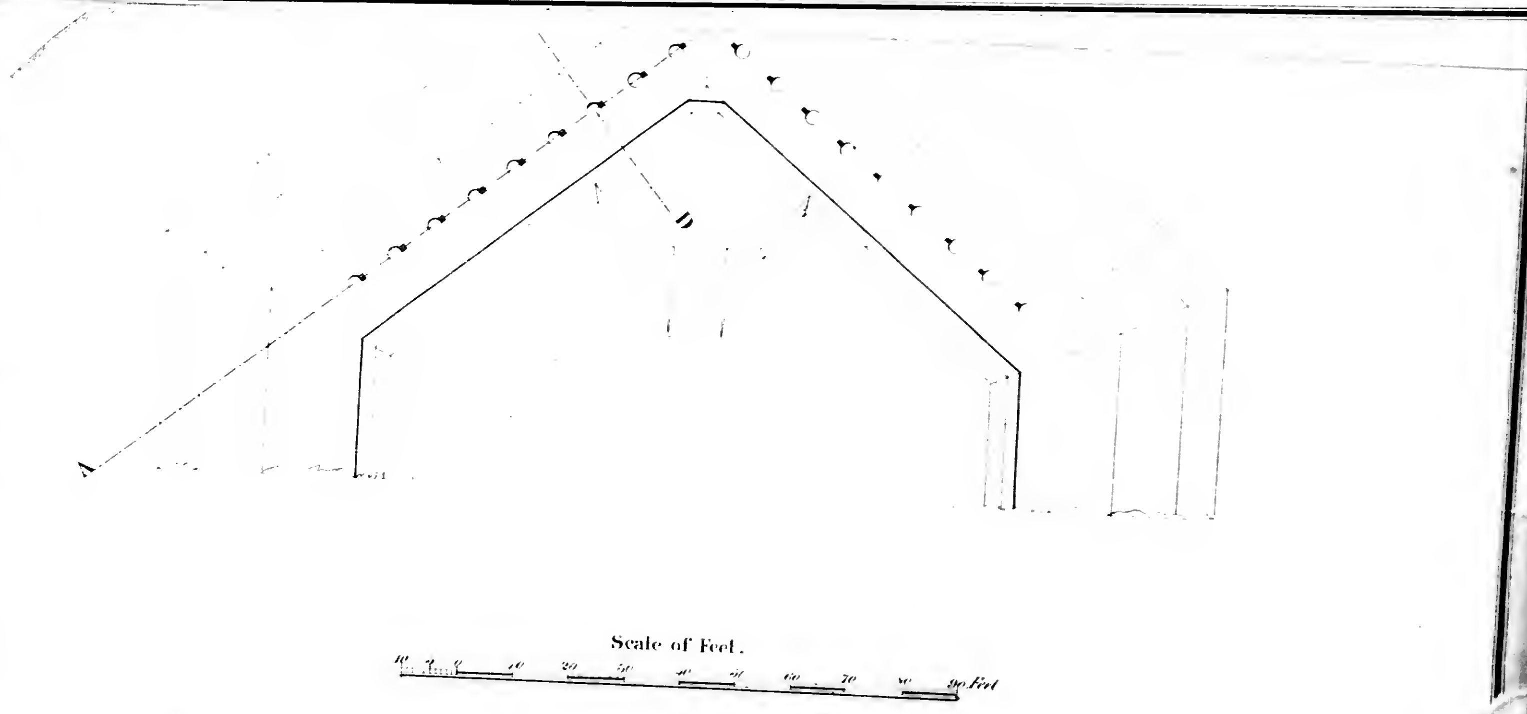
60 100 150 Feet.

...le, 59, High Holborn, 1849.

C.F.Cheffins, Lithog. Southampton Buildings, Holborn.

Operations at Chatham 11^{th} Aug 18[illegible]

Operations at Chatham, 11th Aug. 1848. Plan No. 8.

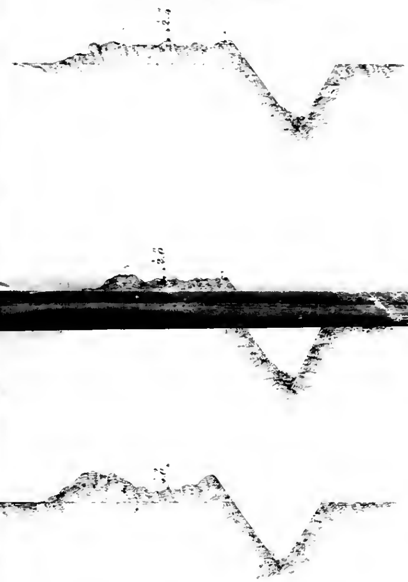


John Weale, 59, High Holborn. 1849.

C.F. Cheffins, Lithog. Southampton Buildings, Holborn, London.

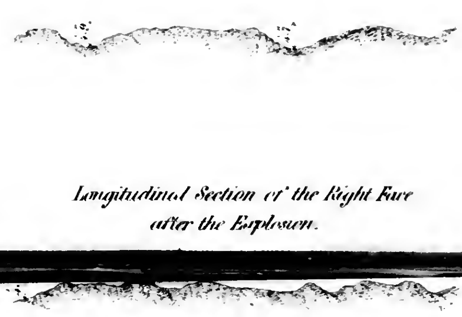
PLAN AND SECTIONS
OF THE
PARAPET OF THE REDOUBT
DESTROYED BY FOUGASSES
AT
CHATHAM
August 11th 1848.

Transverse Sections of the Left Face after the Explosion.

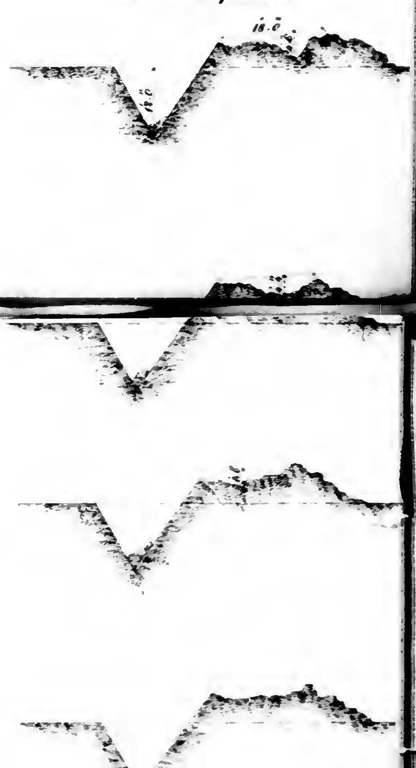


Longitudinal Section of the Left Face after the Explosion.

Longitudinal Section of the Right Face after the Explosion.



Transverse Sections of the Right Face after the Explosion.

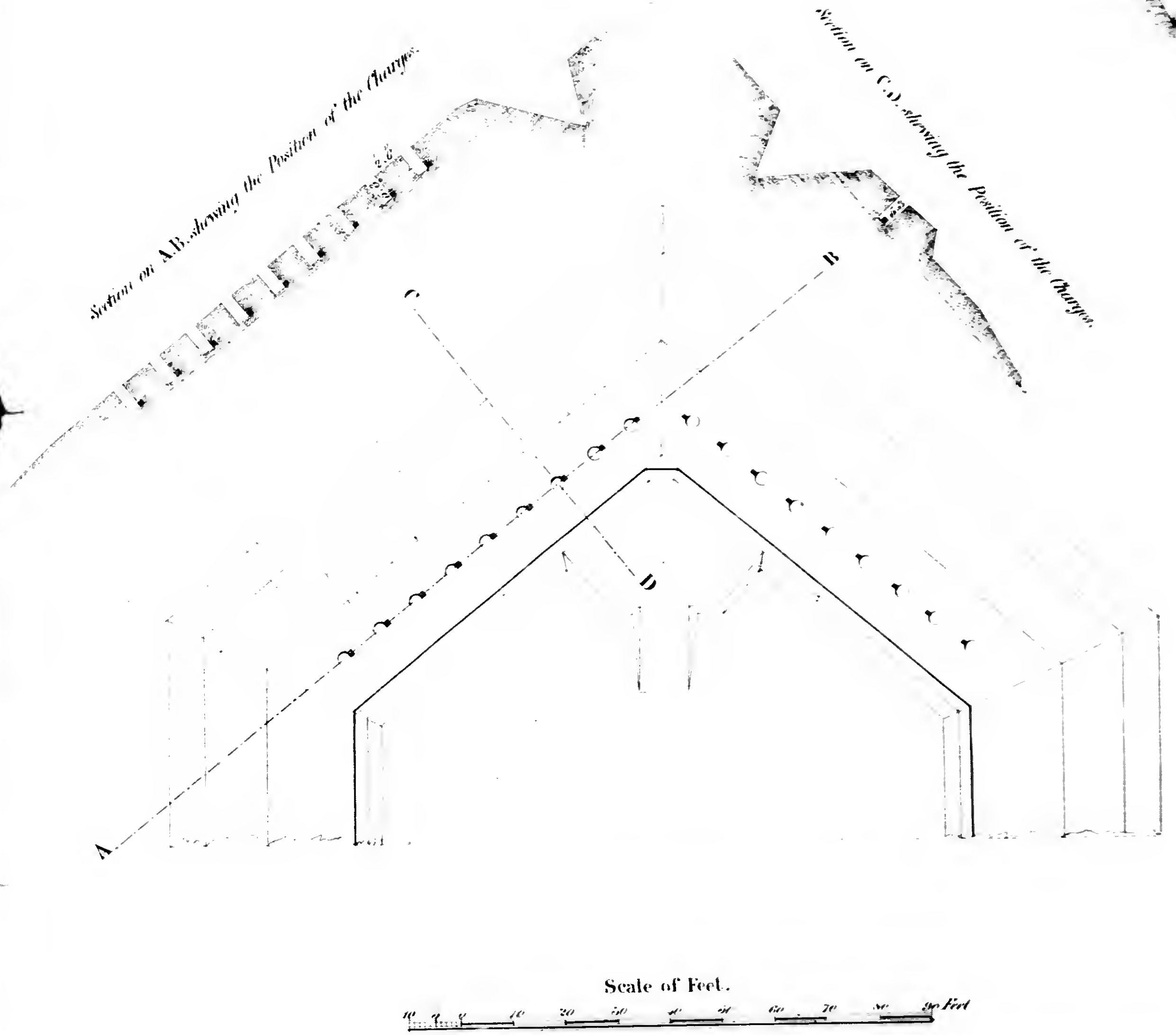


NOTE.

The Lines of Least Resistance were 5 Ft. 3 in. The Charges being each 10 lbs. in Waterproof Bags, and represented in the Section by the black rectangular Figures.

NOTE.

The Lines of Least Resistance were 3 Ft. 3 in. The Charges being each 10 lbs. in Waterproof Bags, and represented in the Section by the black rectangular Figures.



John Weale, 59, High Holborn. 1849.

C.F. Cheffins, Lithog. Southampton Buildings, Holborn, London.

Operations at Chatham. 11th Aug. 18[illegible]

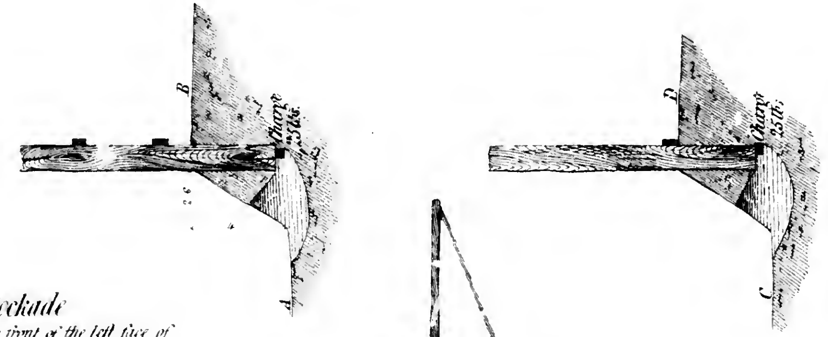
PLAN No. 9.

Sections shewing the position of the Mines and Charges.

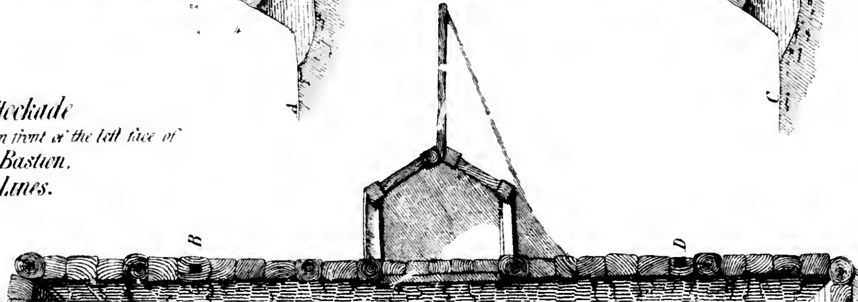
C.F. Cheffins Litho. Southampton B.gs Holborn.

John Weale, 59, High Holborn, 1849

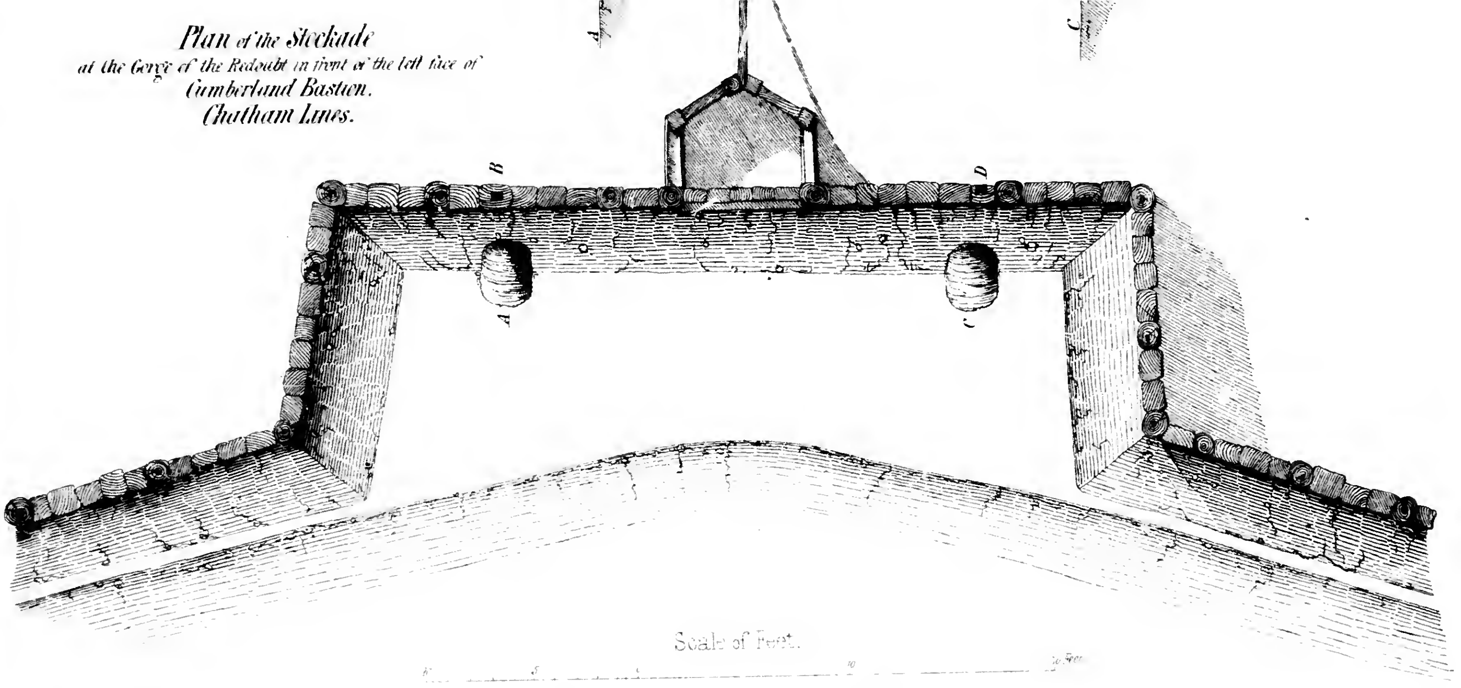
Sections shewing the position of the Mines and Charges.



Plan of the Stockade
at the Gorge of the Redoubt in front of the left face of
Cumberland Bastion,
Chatham Lines.



Plan of the Stockade
at the Gorge of the Redoubt in front of the left face of
Cumberland Bastion.
Chatham Lines.



J. F. Perkins Lithr. Southampton Bridge Holborn.

John Weale 59. High Holborn 1849.

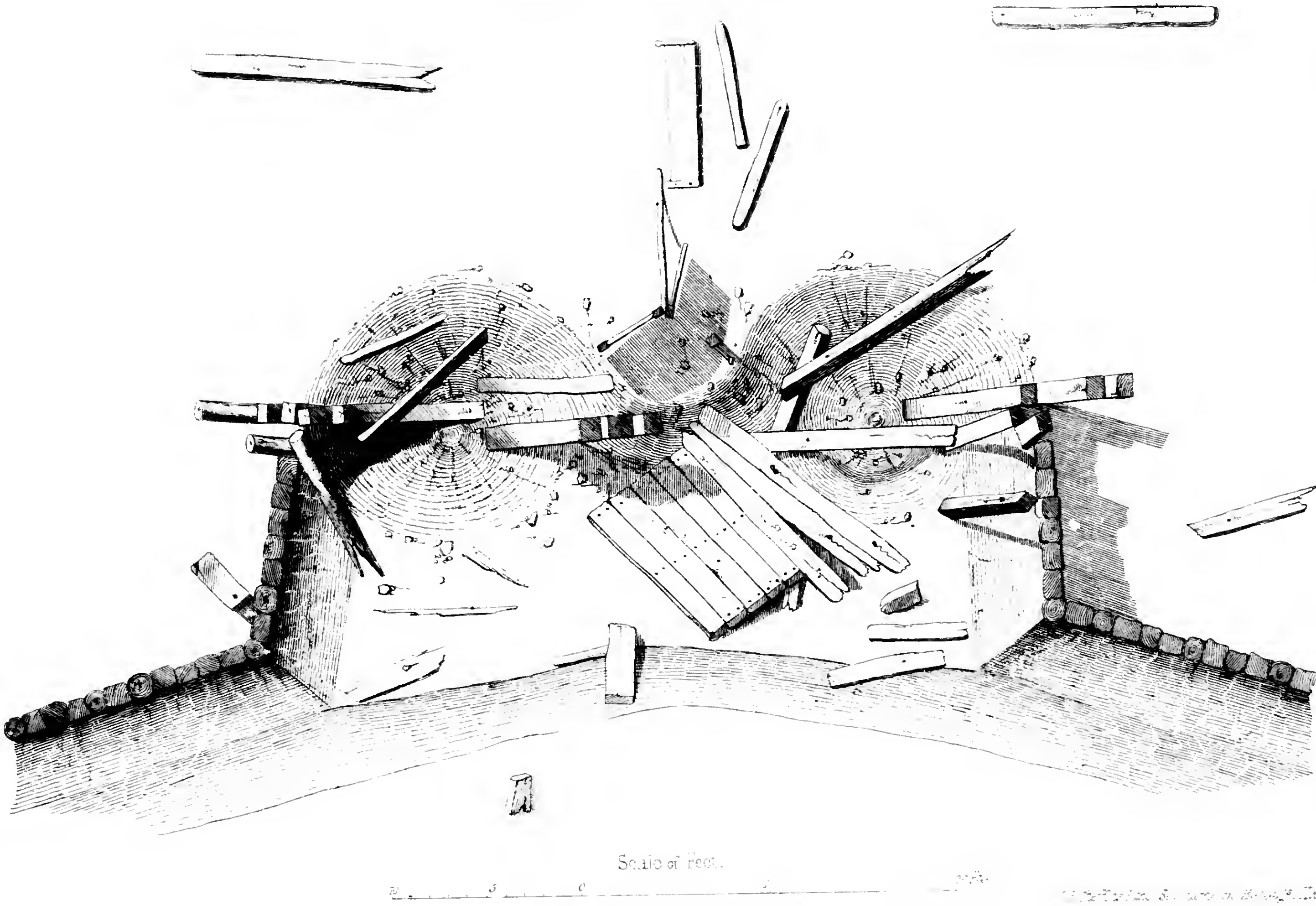
Plan of the Breach in the Stockade.
made on the 11th August 1848.

1000 500 0 1000 2000 3000 Yards

C.F. Cheffins Litho. Southampton Bgs Holborn.

John Weale, 59. High Holborn. 1849

Plan of the Breach in the Stockade.
made on the 11th August 1848.



John Weale, 59, High Holborn, 1849.

Operations at Chatham. 11th Augt 1848.

PLAN No. 11.

Section through the CURTAIN.
shewing the position of the Charges

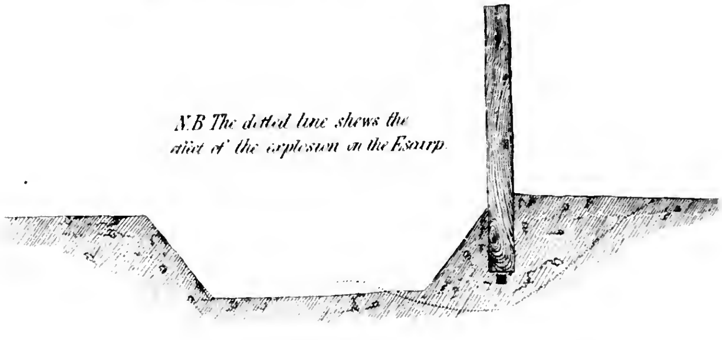
1000 500 0 1000 2000 3000 Yards

C.F. Cheffins Litho. Southampton Bdgs Holborn.

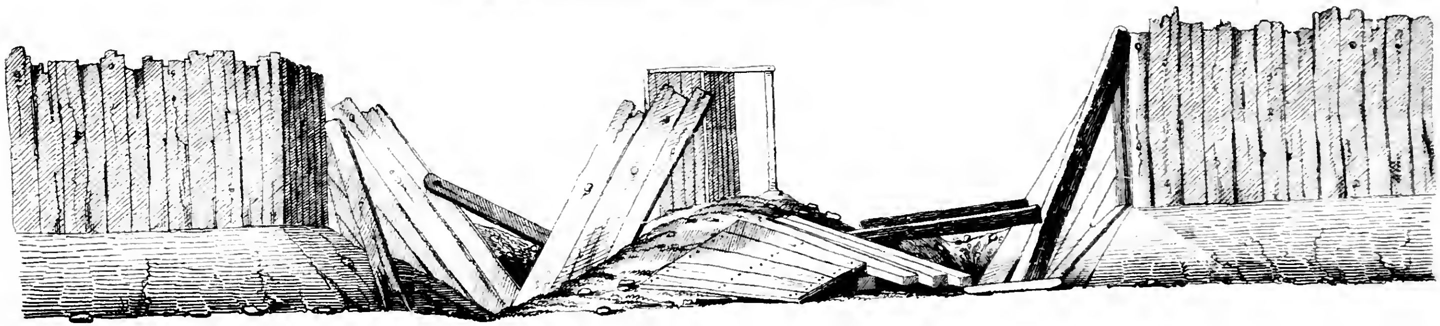
John Weale. 59. High Holborn. 1849

Section through the CURTAIN, shewing the position of the Charges

N.B. The dotted line shews the effect of the explosion on the Escarp.

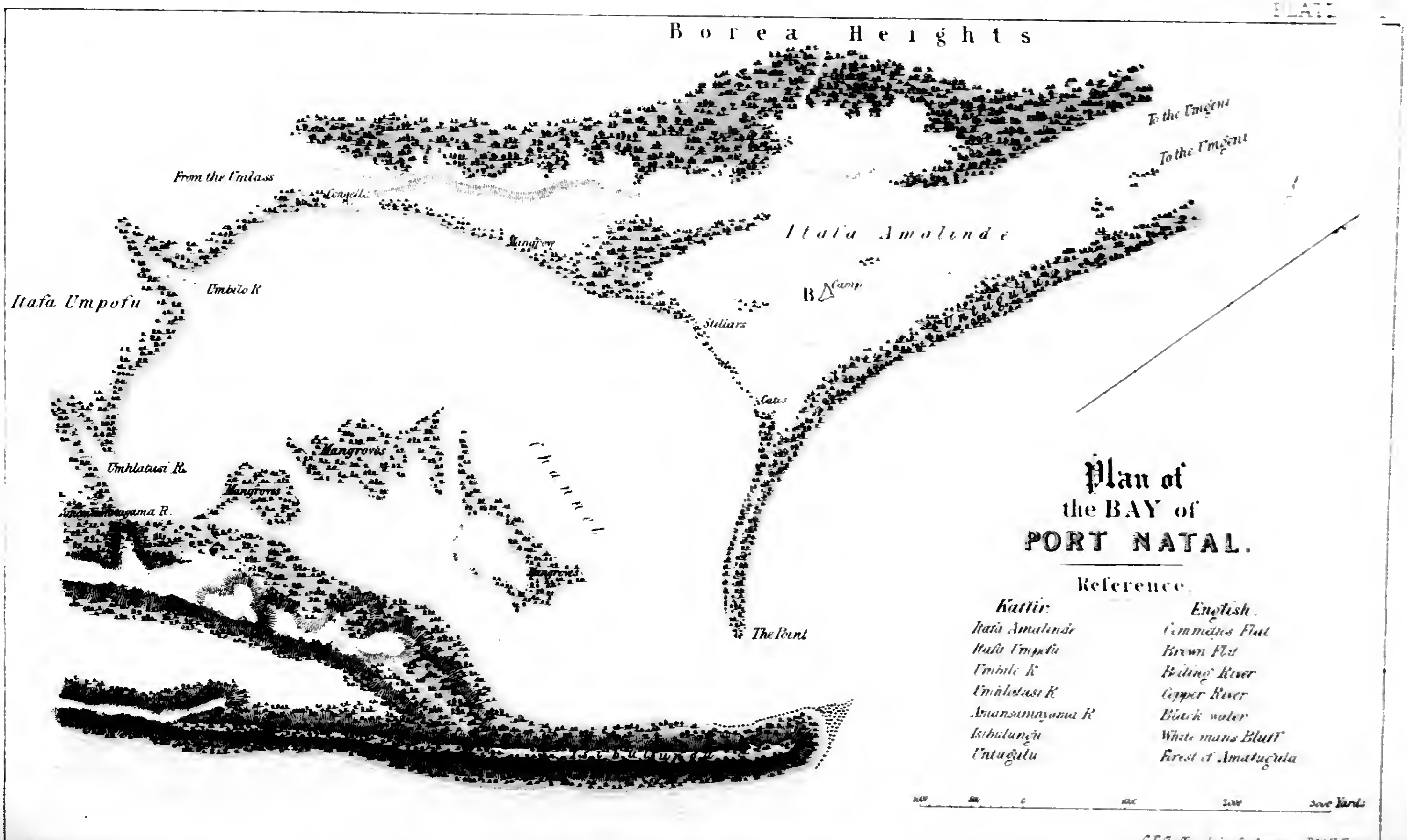


Elevation of the Breach made by the Two Mines.



Scale of Feet

John Weale, 59, High Holborn 1849

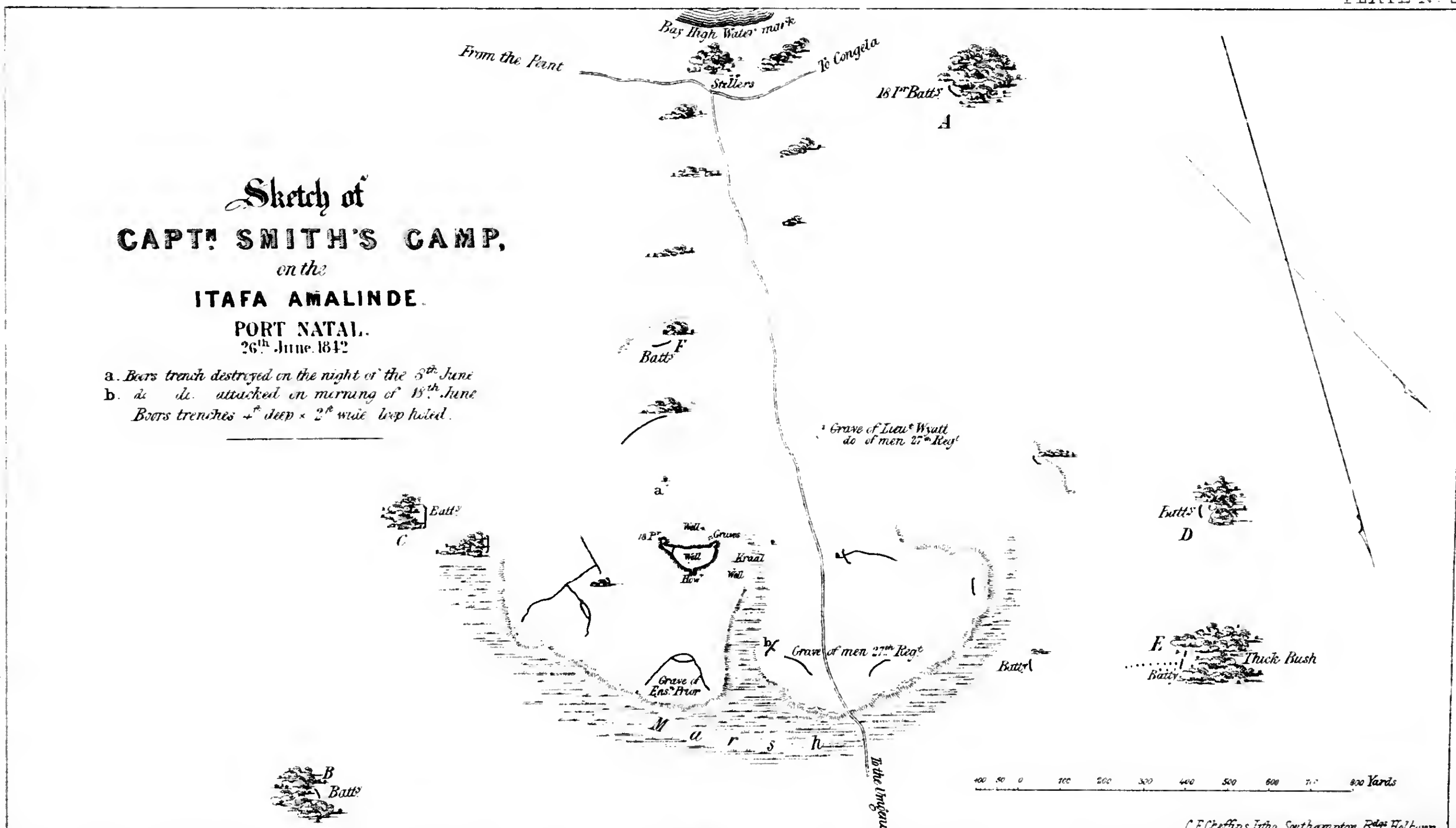


C.F. Cheffins Litho Southampton B[dgs] Holborn

John Weale, 59, High Holborn, 1849

PLATE Nº 2

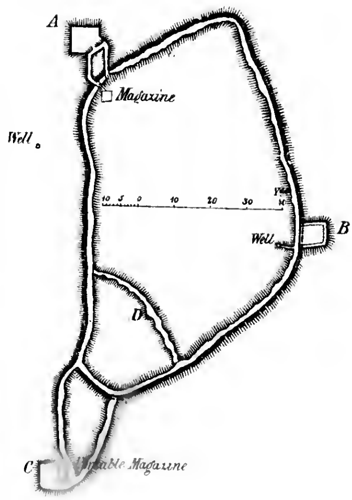
PLATE No. 2



John Weale, 59, High Holborn, 1849.

Enlarged Plan of Camp.

see Plate No. 4.



A. How.^r Batt.^y used for cutting hill tongin

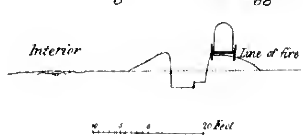
B. How.^r Batt.^y

C. 18 P.^r Batt.^y

D. Trench for Wounded.

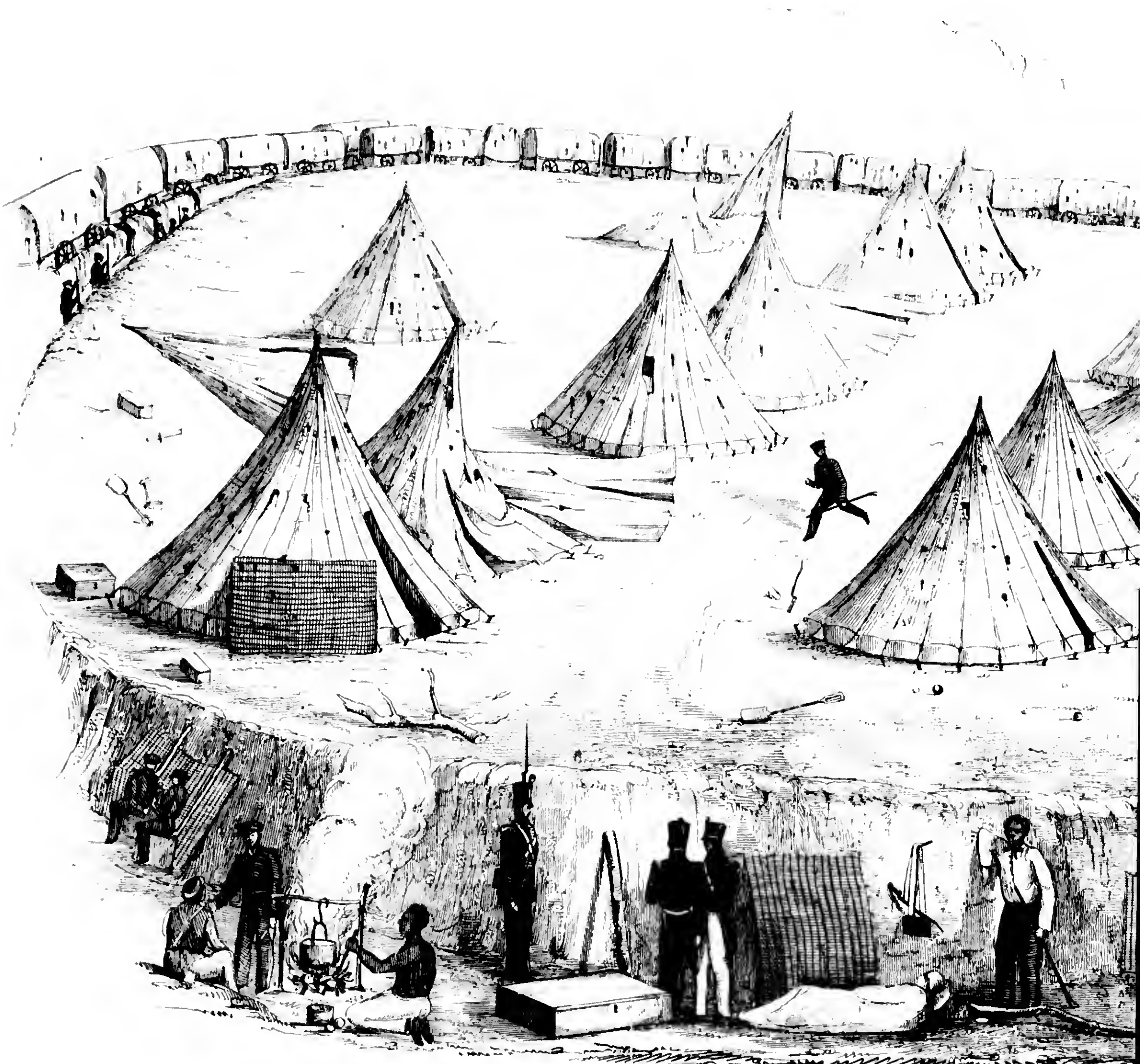
---- Waggons

Section through Trench and Waggons



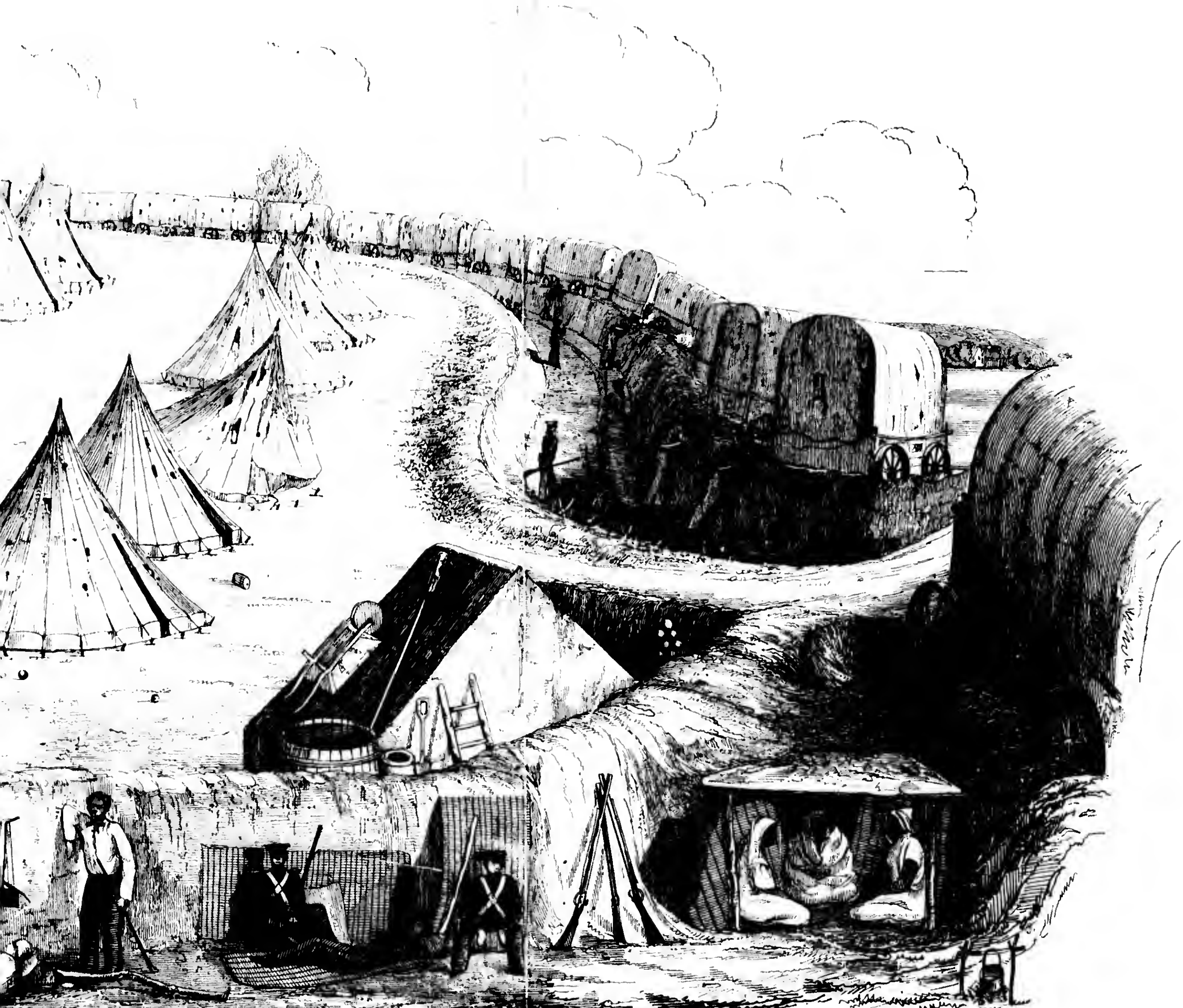
C. F. Cheffins, litho Southampton Bdgs. Holborn

John Weale, 59, High Holborn. 1849.



CAMP ON THE ITAFA AMALINDE, PORT

John Weale, 59, High Holborn



AMALINDE, PORT NATAL, JUNE, 1842.

Weale, 59, High Holborn, 1849.